POWER

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The M. E. B. A.

THE Marine Engineers' Beneficial Association, at its convention held in Washington last week, celebrated the completion of a half century of useful existence.

On February 21, 1875, ten men met at the New England House in Cleveland, and instituted an organization which for fifty years has carried unchanged, the name that they gave to it. The principal prerequisite for membership was the holding of a United States License or commission as a marine engineer, and the objects were stated to be to unite its members fraternally, to improve, maintain, promote and protect the standards of the craft, to regulate the business matters of the craft within its jurisdiction, to render succor to its needy sick and distressed members and to bury its dead.

Its impelling motive was really to present a united front against conditions that had resulted in the reduction of the wages of engineers on the Great Lakes from $130 a month in 1865 to $50 a month in 1875.

During the fifty years that have passed it has remained one of the sanest and most conservative of our national combinations of labor. It has backed up its insistence upon its reasonable demands with scrupulous regard to the character of its membership and to assurance that in moral stamina, courage and reliability the wearers of its insignia should be abundantly equal to the responsibilities that they assume.

We trust that the second half century upon which it is entering may be one of increasing wisdom, prosperity and usefulness, and that long before it has been completed, whatever remains of the bitterness engendered by conflicting interests may be lost in the broader appreciation of the inclusive welfare of the service, embodying employer and employee alike, that individual or class interest may have at times obscured.

F. R. Low

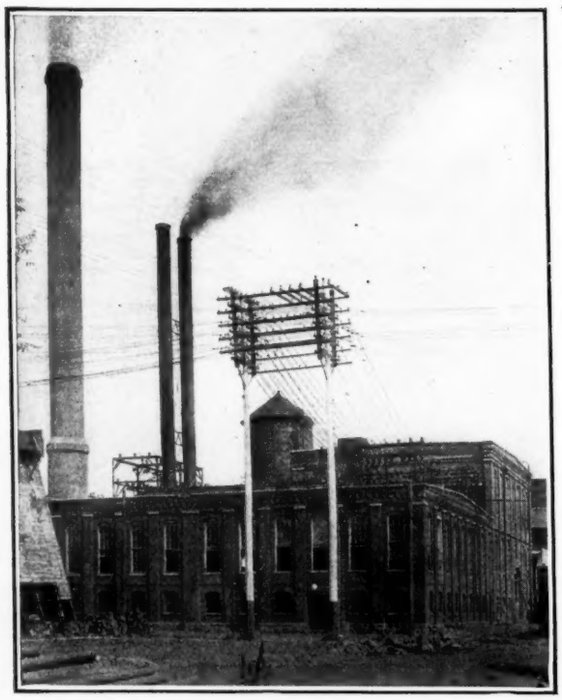


Fig. 1—Original station at center of load and heating distribution

Revamping Station at Springfield, Mo.

By J. D. BOWLES
Chief Engineer, Federal Light & Traction Company

WATER-SEALED ashpits behind boilers one of outstanding features involved in modernizing and enlarging plant of the Springfield Gas & Electric Co.; other changes include increased steam pressure, water-cooled furnace walls, forced draft cooling tower and live steam at 125 lb. to replace district heating with exhaust steam.

THE City of Springfield, situated on a plateau in the Ozark Mountain region of southwestern Missouri, at an elevation of approximately 1,400 ft., obtains its electricity, gas and district steam-heating service from the Springfield Gas & Electric Co. This company also supplies power both to the Springfield Traction Co. under the same ownership and management, and to the Springfield City Water Co., the local utility, for its pumping requirements. This community has a population of about 60,000.

Prior to 1913 a plant, Fig. 1, near the geographical center of the city supplied all the electrical and steam-heating requirements. The prime mover and boiler equipment consisted of an 1,800-kw. turbo-generator, 1,500-kw. capacity in three Corliss engine-driven generators, and six hand-fired water-tube boilers, 170 lb. pressure with no superheat, having a combined rating of 2,300 sq.ft. These were served by a concrete chimney 150 ft. high, having a 96-in. flue, and two steel stacks 100 ft. high by 48-in. diameter. Coal was unloaded from the freight cars to the boiler-room floor and storage by hand, and ashes were scavenged by wheelbarrow. Water for boiler-feed makeup, etc., was secured from a drilled well 900 ft. deep. The building was a brick structure, entirely above ground level, with concrete floors and wooden roof.

Beginning in 1913, an electrical connection was effected with the 66,000-volt transmission line of the Ozark Power & Water Co. just completed, linking a hydro-electric generating station some forty-five miles south on the White River with the Empire District Electric Co. system, a hundred miles west of Springfield. A fireproof substation was built adjacent to the Springfield Gas & Electric Co.'s plant to step down the incoming 66,000-volt supply to 2,300 and convert it from 25 to 60 cycles. Outside of the water company's and one or two minor installations, 60-cycle frequency was retained as the standard for Springfield and vicinity.

No further improvements were made in the Springfield station until 1922, when it was decided that the importance of the rapidly growing electric load justified the installation of more adequate and efficient local steam electric generating facilities to supplement hydro-electric power and protect service from interruptions

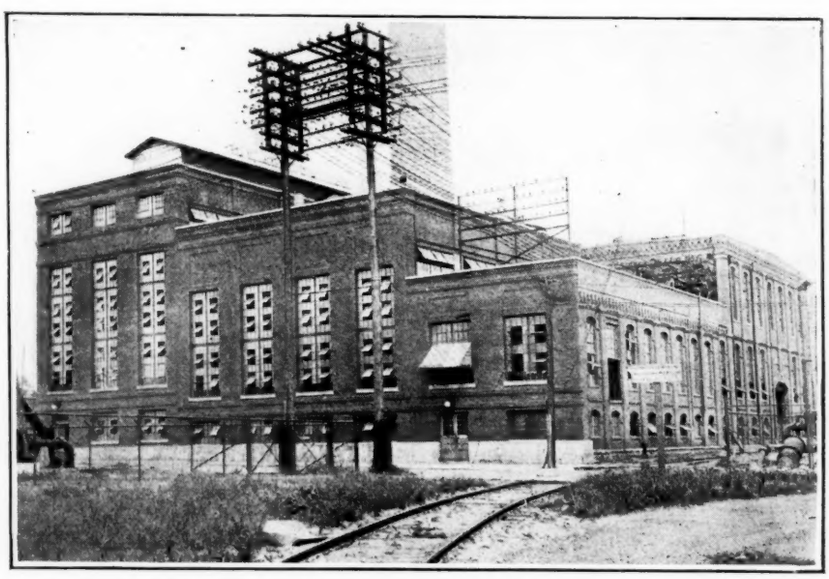


Fig. 2—Station rebuilt at increased steam pressure without service interruption

due to transmission-line failures. In the meantime, a careful study had been entered into, covering various possible schemes which would result in a thoroughly dependable installation at the lowest total annual cost, taking into account the fundamentals, as in Table I, which would naturally shape the development of any plan finally pursued.

Fundamentals Determining the Character of Additional Power Equipment

I. Present and probable load conditions forecasted for a reasonable time into the future.

II. Present and probable future cost of the various available fuels, namely: Bituminous coal from the fields of Kansas, Missouri, southern Illinois and semi-anthracite from Arkansas and eastern Oklahoma, and also oil.

III. The probable perpetuation of the steam-heating system.

Among the plans considered were the following:

(a) Diesel-engine generating station adjacent to present station, using the existing steam equipment as reserve to one engine unit.

(b) Building a new station just outside of probable future city limits, with condenser cooling water supplied by artificially created lake or spray pond or a combination of the two.

(c) Building a new station on the James River on a branch line of the St. Louis, San Francisco Railway, where sufficient natural stream flow is available a major part of the year for all present and probable future cooling-water requirements, a spray system to supplement natural stream flow cooling when necessary. A ten-mile high-voltage interconnection would be required between this station and the old one which would be retained as a low-pressure heating plant, a receiving point for hydro-supply, and distributing center for alternating- and direct-current feeders, railway supply, etc.

(d) Installing additional steam prime-mover equipment in existing building, razing old boilers, installing stokers or oil firing and mechanical coal- and ash-handling facilities or provisions therefor.

(e) Purchasing additional steam prime-mover equipment for the existing station site, replacing old boilers by higher-pressure units with mechanical coal and ash handling and necessary remodeling of building to provide a fireproof structure of ample size for present and near future needs, with ample facilities for extensions to accommodate any probable future needs.

Note: With either scheme (d) or (e), condenser circulating water was to be cooled by spray pond or forced-draft towers.

Scheme (e), in conjunction with forced-draft cooling towers, was decided on, plans and specifications drawn up, materials purchased and construction work rushed to completion. Forced-draft cooling towers were selected in place of a spray pond because of their ability to crowd capacity on a given ground area and the less possibility of drifting spray nuisance. The completed station appears in Fig. 2.

The five original boilers were replaced by three 8,900-sq.ft. 275-lb. pressure Stirling boilers, equipped with superheaters for 150 deg. F. nominal superheat, set with centers of lower drums 12 ft. above boiler-room floor. One of these boilers is stokered by a new type underfeed, grate area 179.8 sq.ft., and two boilers by combination traveling grate and stationary tuyere stokers, grate area 223.5 sq.ft. Each stoker is served by an independent blast fan driven by variable speed alternating-current motor located in a ground-floor room immediately beneath the boiler room. The maximum air requirement for the underfeed stoker is 39,000 cu.ft. per min. at 5 in. pressure, and for the traveling grate stoker 41,000 cu.ft. per min. at 2 in. Economizers were not justified, owing to the intermittent character of operation and probable future fuel prices. The combination of stokers, setting and new 265-ft. radial brick stack was calculated to permit operation of at least two boilers simultaneously at 250 per cent of rating continuously, with 300 per cent for brief intervals for any boiler, on ordinary run of Kansas screenings. (Subsequent operation has fulfilled this expectation.) Each boiler is equipped with six valve-in-the-head type soot blowers.

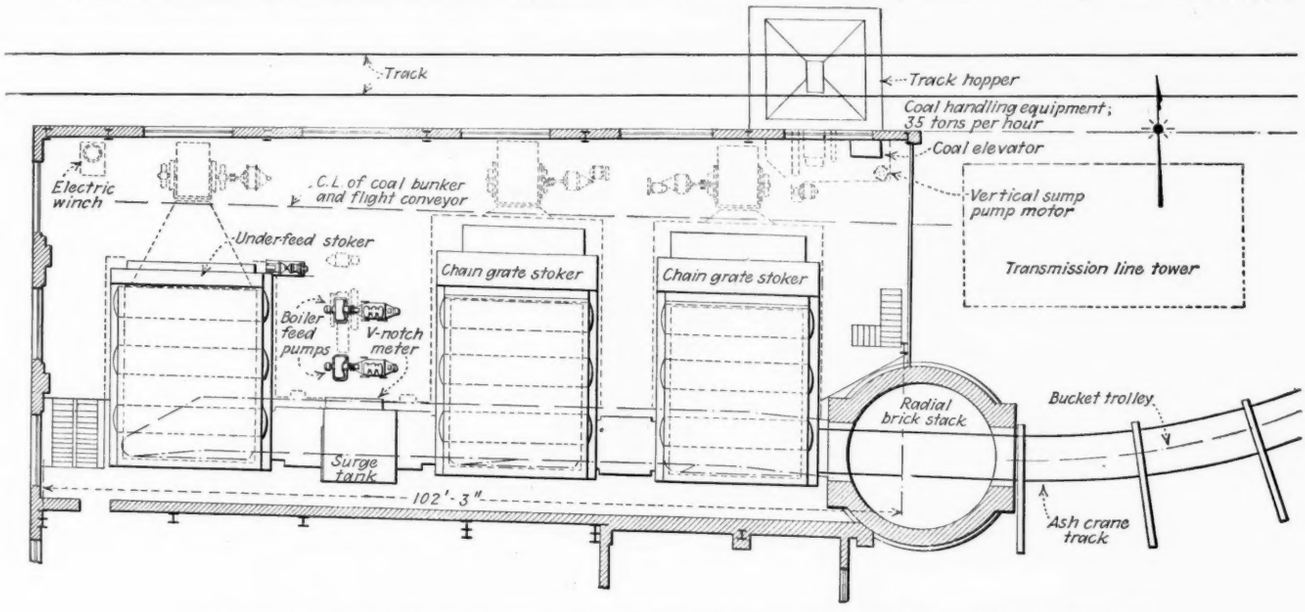


Fig. 3—Plan showing ash crane runway through stack, the latter serving as storage

Coal is dumped into a track hopper, Fig. 3, beneath railway siding along the boiler-room wall and, after passing through a feeder and crusher, is elevated to an overhead steel bunker running the entire length of the boiler room by bucket elevator with a speed of 120 ft. per min. A flight conveyor is employed to distribute coal in the bunker. This coal-handling equipment has a capacity of 35 tons per hour. Cars may be shifted

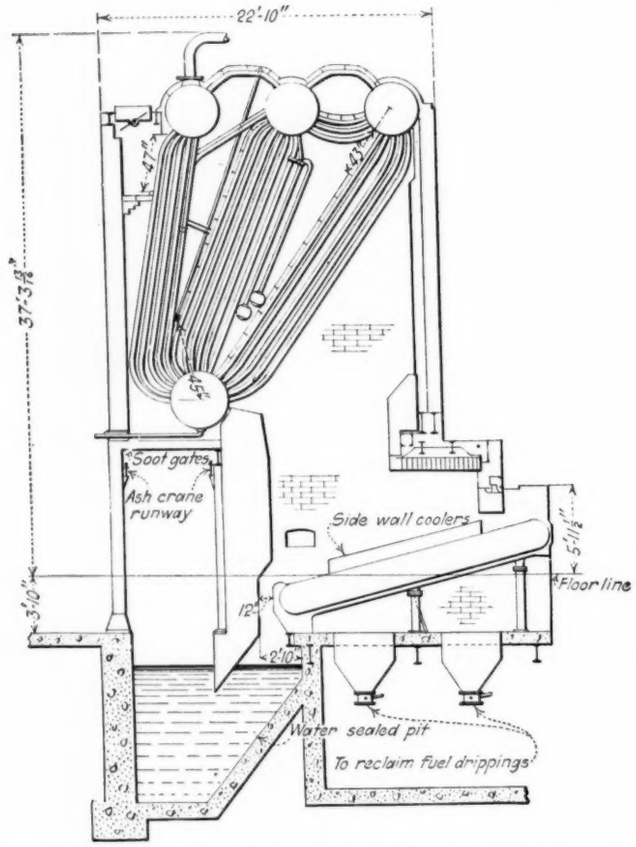


Fig. 4—Stokers without grinders dump into water-sealed pit with crane behind boilers

along the siding after delivery, by an electrical vertical winch.

A gasoline-operated, caterpillar-type locomotive crane was purchased at the beginning of the work for construction purposes, and later retained as part of the regular coal-handling equipment, principally unloading coal to and from storage. This crane, by the way, saved its original cost in unloading construction material from the cars, erecting steel by the use of an extension boom, pouring concrete, hoisting brick, etc.

A water-sealed, concrete ashpit was decided upon at the rear of boilers, running the entire length of the boiler room. Although such pits are not uncommon, it is believed that this is the first installation on record where the water-sealed ashpit, its crane, etc., were installed at the rear of the boiler instead of entirely underneath.

The headroom between floor line at the rim of the pit and the lower boiler drum is sufficient to accommodate the ash crane equipped with grab bucket. The ash-crane runway passes on out through an opening in the stack near its base to outdoors where the ashes may be dumped into truck or railway cars as in Fig. 3. The base of the stack is utilized to store ashes temporarily when it is not convenient to load them while scavenging.

The water-sealed ashpit has the advantage of insuring at all times against excess air in furnace via the ashpit route, it provides relatively large storage capacity between crane operations, maintenance is low and a comparatively small amount of water is used in quenching. The installation of the pit behind instead of beneath the boilers, Fig. 4, permits of lower clearance for the entire boiler-house structure than would be possible either with water-sealed pits beneath the boiler room or the conventional ash hopper and gates beneath each stoker. The scheme is thoroughly practicable for small and medium-sized plants, as a year's experience in Springfield has already demonstrated, and may be adapted to straight-tube as well as bent-tube types of boilers, as shown by preliminary plans developed for this layout.

Stokers Dump Directly Into Water

An unusual arrangement is that the stokers dump directly into the water, no clinker grinder being employed for the underfeed stoker because of the quantity and character of the ash. It may also be observed that the water in this pit does not become unduly hot, even after hours of steady operation of the plant at full load.

Siftings from the traveling grates are collected in hoppers beneath the stokers and at convenient intervals dumped into wheelbarrows on the floor below and wheeled to the boot of the coal elevator and sent back to the coal bunker above.

Because of the absence of the conventional ash hoppers, the ground-floor space beneath the boiler-room floor is exceptionally clean and dry and is utilized to accommodate the stoker blast fans, damper regulator apparatus, station air compressor, emergency oil-burning equipment for one boiler, etc.

The breeching connecting the boilers with the stack is unlined and uncovered. This is carried in a monitor on the boiler-room roof, as shown in Fig. 5, and thus is protected from radiation and the action of the elements while conserving the heat of the gases for stack draft. Access to all sides is provided for inspection and repairs; one side of the monitor is equipped with an adjustable glazed sash.

Side Wall Waterboxes Prevent Clinker

The high ash content of the coal ordinarily used in Springfield, combined with the low fusing point of the ash, produces a stream of molten slag running down the side walls of the traveling-grate stokers at medium and high ratings with a corresponding tendency for clinkers to build out over the fire from these walls. The side-wall tuyeres of the underfeed stoker appear to protect it from any trouble from this source, but the perforated side wall originally installed over the traveling grates did not prevent clinkers from building out over the fire and interfering with the uniform progress of the fuel bed, necessitating frequent removal by a slice bar inserted beneath the stoker grate. This performance is not only hard work, but soon destroys furnace linings.

Accordingly, cast-iron side-wall water boxes were installed and protected by circulating water through them from the overhead condensate tank, which produced immediate relief from the clinker trouble. Higher ratings were possible and over-all boiler and furnace efficiency was increased. They complicated the boiler-

house piping, however, and soon burned out either from carelessness or because cast iron is not a suitable material for this purpose.

Arrangements are now being made to install coolers constructed of 3½-in. No. 6 gage boiler tubes, three to each side wall, spaced closely and located immediately above the stoker. These tubes are to be made a part of the boiler circulating system or heating surface through junction boxes connected to the front upper drum and the upper part of the lower drum by 4-in. tubes. This installation should work out satisfactorily provided the insides of the tubes are kept clean. The water-sealed ashpit permits of large clearance between the rear of the stoker and bridge wall so that no water-back is necessary.

All the new boiler-house equipment has been installed over the same ground area occupied by the six original hand-fired boilers. The old boiler room was crowded, but the new one, housing far greater capacity, 26,700

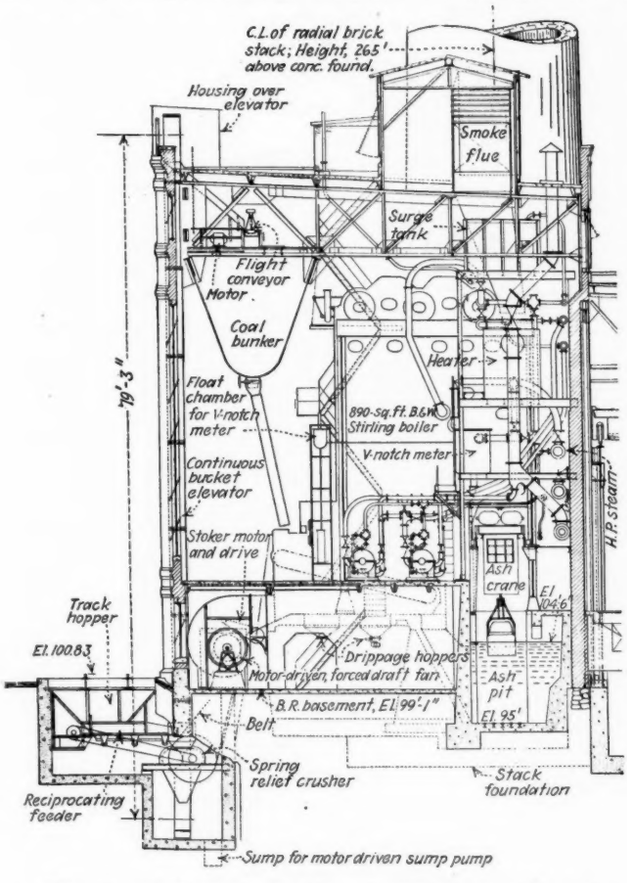


Fig. 5—Unlined smoke flue carried in monitor on boiler-room roof

sq.ft., with mechanical coal and ash handling, provides ample working space around the boilers and other equipment. Cleanliness has become an outstanding feature as a result of water-sealed ashpits.

The first new unit installed in the engine room was a 5,000-kw. turbine generator in the space originally occupied by a 300-kw. Corliss-engine-driven unit. The 1,800-kw. turbine was left in place, as also the two remaining engine-driven generator units, all of which may be operated from 160 lb. steam supplied from the old low-pressure header, which is in turn fed from the new high-pressure header by a reducing valve. Ultimately, the two remaining engine units will be dismantled and replaced by a turbine generator of 10,000 kw. or thereabouts.

The question may be asked, "Why the moderate steam pressure and temperature, and absence of bleeding generating units for feed-water heating and perhaps all or a portion of steam-heating requirements?" The answer is that this station is intended for intermittent operation and primarily as a safeguard to Springfield's electrical supply, where simplicity and reliability are of utmost importance, and any fuel saving due to these additional refinements may be more than counterbalanced by additional fixed charges, maintenance and operating labor incident thereto.

Air is evacuated from the 5,000-kw. turbine condenser by a 2-stage steam-jet air pump, the heat from the steam jet being taken up by the condensate on its way to condensate storage and any excess steam condensed through a bypass connection from the cooling-water circulating system.

Circulating water for the 10,000-sq.ft. condenser is cooled by a forced-draft cooling tower of the splash and drop type, this tower being built in five cells, each 16x24 ft. and 37 ft. high. Each cell has two disk fans 120 in. in diameter mounted on a common shaft and driven by a 50-hp. induction motor at 181 r.p.m. through a silent chain drive. Spray eliminators consisting of wood strips in louver formation were placed across the top of the tower several feet below the rim, trapping about 90 per cent of the spray which would otherwise be blown out of the top. These spray eliminators do not cause any appreciable back pressure or retardation to flow of air and vapor. They were put in after trial runs demonstrated that without them sufficient spray issued from the tops of the towers to create a possible nuisance to adjacent streets and the company's as well as neighboring property.

Bearings Fitted with Hardwood Liners Without Oil Lubrication

The intermediate journal bearings located within the body of the tower, which are exposed to falling water and spray, are hardwood-lined with no oil lubrication. The end bearings are lubricated by a pressure grease system. The water and pressure grease lubrication system was adopted after various unsuccessful efforts to eliminate washing of oil from fluid-oil lubricated bearings.

The chain drives were adopted in place of belt drives originally installed after experience demonstrated that it was impossible to keep belts from slipping and becoming damaged when wet from spray or natural rainfall. The present motors driving fans are 50-hp. squirrel-cage type. Slip-ring starting instead of squirrel-cage method is now being considered because the starting shock to fans and bearing supports with squirrel-cage motors is too severe. Slow-speed direct-connected motors, possibly of the synchronous type, may be adopted for future units.

Each water riser pipe (one 12 in. to each cell) has been equipped with a quick-opening gate valve since the tower was constructed, which permits, when desirable, of varying the number of cells operated according to the load. Each fan motor may be started and stopped by push-bottom control from the engine room.

The cooling tower is built over a concrete basin which was extended at the time of building for five additional cells. The basin has a capacity of 500,000 gal.; a relatively large storage which permits of oper-

ation on the deep-well source of water at a limited rate of pumpage, as the water pumped during the off-peak period supplies the deficiency during the peak-load period.

The operating staff reports that its experience to date with this forced-draft cooling-tower installation indicates about 30 per cent more cooling capacity than it now furnishes is desirable to serve the 5,000-kw. turbine generator unit suitably. This capacity will be obtained by speeding up the fans if practicable and installing additional cell or cells. There is ample space on the parcel of ground upon which the cooling tower is constructed for a total of twenty cells. Other adjacent real estate owned by the company will accommodate cooling-tower capacity.

A condensate storage tank of ample capacity, open-type feed-water heater and V-notch feed-water meter are installed on a tower structure between Nos. 1 and 2 boilers in the space originally occupied by the concrete chimney. Two feed pumps are situated on the boiler-room floor beneath. These feed pumps are 4-in., 3-stage, double-suction centrifugals having a capacity of 350 gal. per min., and steam-turbine drive. Each pump is equipped with a 2-in. pump governor operated in connection with boiler-feed controllers.

The V-notch and condensate storage tanks are steam-sealed. There is also a thermostatic live-steam connection to the heater, this steam being admitted into the heater from a perforated pipe in the water storage space which insures a steam seal in case of deficiency in exhaust steam. These precautions are observed to keep down the dissolved gas content in feed water to as low a value as practicable without the installation of special deaërating equipment. It also insures the removal of a certain amount of soluble matter from the makeup water which would otherwise be precipitated in the boilers.

How Deep-Well Capacity Was Increased

Station water supply is secured from the original well 900 ft. deep by an 8-in. double-acting pump 36-in. stroke, 40 r.p.m. The distance to water at maximum draw-down is 180 ft. Originally this well was fitted with a motor-driven double-plunger pump, 36-in. stroke, with 6¾-in. working barrel 250 ft. down. When the plant was reconstructed, this working barrel was replaced by the largest size which the well would take, which was 8 in. diameter, and a new and heavier pump head was installed with a variable-speed motor which gave the well a capacity of 285 gal. per min. at 40 r.p.m. This pump discharges into a 70,000-gal. elevated tank (part of the original equipment) which supplies boiler-feed makeup and general station service, then overflowing into the cooling tower basin which also receives a supply from various raw-water drains about the station. An emergency connection from the city water mains is provided.

The steam-heating system at Springfield distributes at low pressure, metering by means of condensate meters on the consumers' premises. This condensate is ordinarily dumped into a convenient drain or sewer, and no provision is installed to return any of it to the boiler plant. Steam is usually turned into the mains in September and shut off the following May. While the old station was operated steadily prior to 1913, the heating system received its steam from the engine exhaust and the bleeder connection on the 1,800-kw Curtis turbine. After the introduction of hydro power, live steam was used to a large extent.

The first 1,500 ft. of main leaving the power station was located in low-lying soil, usually damp and during rainy periods soaking wet, drainage being attempted by a sump pump because a portion of the main lay below the city sewer level. This low-lying main has recently been abandoned, but is left in the ground for possible emergency use, and a new feeder main has been laid over a different route. This new main is of 125 lb. pressure with multi-cell insulated construction. It is laid just deep enough to be well protected from overhead traffic; with every precaution observed to insure proper drainage under all weather conditions. The pipe size is smaller than the original main replaced, so that the pressure drop of this main, coincident with the pressure-reducing valve at the power station, is utilized in stepping down from boiler pressure to approximately 5 lb. at the center of distribution of the heating system. The smaller feeder size keeps down the initial investment, reduces maintenance charges and minimizes radiation losses, these losses being exceedingly important factors in the operation of any district steam-heating system.

Heating Steam Desuperheated to Protect Wood Insulation

Live steam introduced into the heating system is partly desuperheated to prevent destroying the wood-log insulation now existing on a considerable part of the distributing system. Experience has demonstrated that this covering will carbonize and actually catch fire at temperatures prevailing 2,000 ft. from the plant with 10 lb. pressure steam supplied direct from the high-pressure station header without desuperheating. The steam is consequently desuperheated by water spray after expanding into the heating system. Arrangements have been made to reinsulate a large section of distribution system nearest the supply feeder with multi-cell insulation so that artificial desuperheating at the station may be reduced or entirely omitted. A moderate amount of superheat in all or a greater portion of the heating system is considered desirable so as to minimize condensation in the mains. This condensation is more or less of a nuisance to get rid of, causes water-hammer and also carries away considerable sensible heat.

The dismantling of the old 150-ft. reinforced-concrete chimney involved an unusual problem. It was removed piecemeal, principally by the use of pneumatic tools, the dislodged material being thrown down the inside and removed from below. The entire cost of removing this stack was $1,341.

It was, of course, highly desirable in rebuilding this station to minimize interruptions to electric and steam-heating service. So carefully was the work planned and carried out that no consumer was aware of any unusual behavior in the service supplied to him from this company's system.

The design and construction of this remodeled station was carried out by Sanderson & Porter, engineers and contractors, of New York, under the supervision of the engineering staff of the Federal Light & Traction Co. of New York, which controls the Springfield Gas & Electric Co., E. N. Sanderson being president of both concerns. C. H. Nichols is vice-president and general manager of the Federal Light & Traction Co. and A. E. Reynolds, vice-president and general manager of the Springfield Gas & Electric Company.

Methods of Rope Drive on Electric Elevator Machines

Common Methods of Roping up Drum and Traction Elevators and Their Advantages and Disadvantages

By CHARLES A. ARMSTRONG

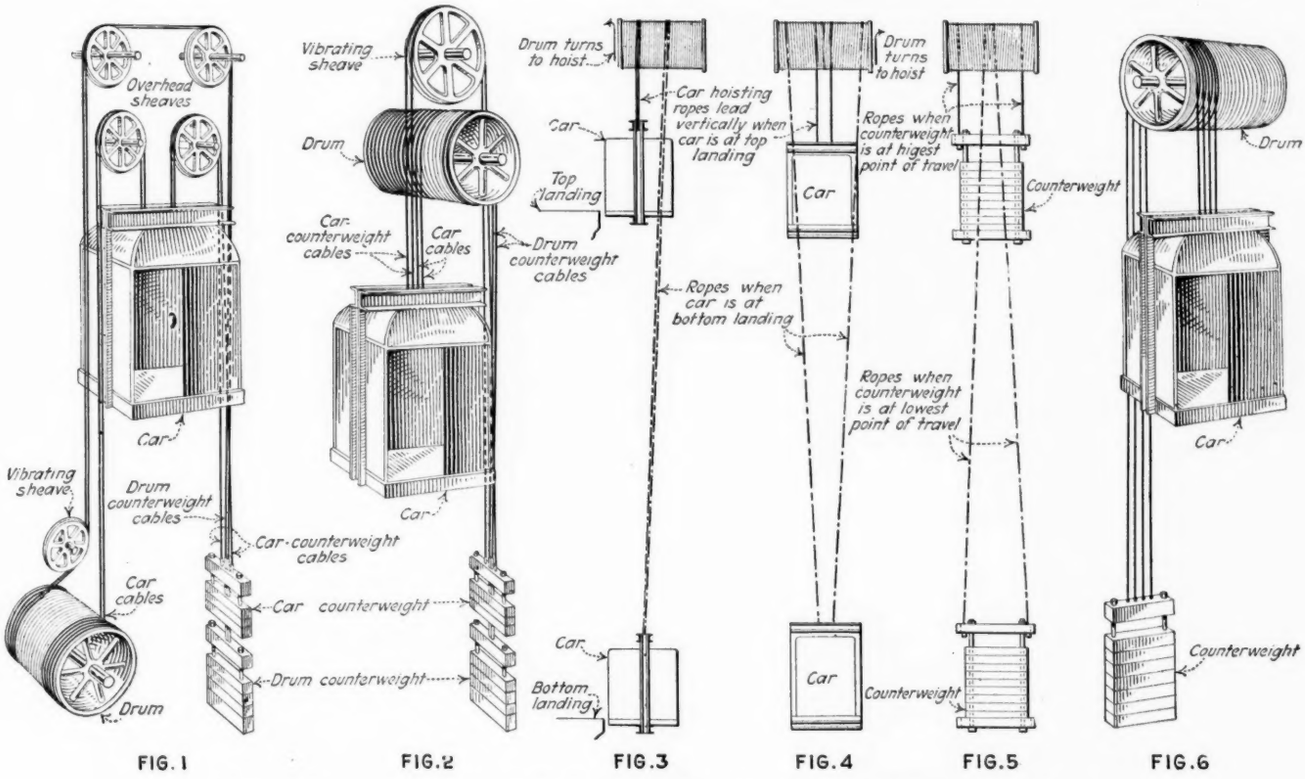
PRACTICALLY all earlier types of electric elevator machines were of the winding-drum type, but, in present-day practice this type is being rapidly superseded by the traction types of machine. On the drum-type machine there are generally three sets of cables. One set, the car cables, has one end attached to the car and the other to the winding drum; a second set, the drum-counterweight cables runs from one of the counterweights to the drum; the third set connects the car to the car counterweights. All these are clearly shown in Fig. 1 for a basement-type installation.

The overhead drum-type elevator installation, Fig. 2, simplifies the roping up considerably and requires only about one-half the length of cables from the car and from the counterweights to the drum. The car counterweight cables are about the same length in either installation. The general arrangement of the cables is clearly shown in the figure, where the car and drum-counterweight cables lead off opposite sides of the drum, with the car counterweight cables passing over the vibrating sheave and to the counterweights. Where the drum spans less than half the width of the shaft, a deflecting sheave is required to lead the counterweight cables vertically down the shaft.

These types of machines are limited to relatively short rises of about 150 ft. or less. For higher rises the drum becomes of an unwieldly length to provide space on which to wind the cables. With a drum of given diameter a different length is required for each height of travel of the car. For example, on a 100-ft. rise a drum would have to be provided that would have space for winding up 50 ft. more cables than on a 50-ft. rise.

Another objection to the drum-type machine is that in case the limit and control devices fail to cut the power out of the motor at the terminal landings, the car or counterweights may be pulled into the overhead work. In such an event the cables may be pulled out of their sockets and the machine wrecked.

With the overhead type of machine, Fig. 2, the cables have to bend in only one direction when winding on and off the drum, and as there is no creeping, long life of the cables is assured under normal conditions. When



Figs. 1 to 6—Different methods of roping up drum type elevator machines

Fig. 1—Basement installation. Fig. 2—Overhead installation. Figs. 3 to 5—Show how the cables lead off the drum for different positions of the car and counterweights, on an overhead installation. Fig. 6—Drum-type traction machine.

such machines are installed in the basement, as in Fig. 1, reverse bends are encountered, as the cables bend around the different sheaves, which tend to shorten the cables' life.

In an overhead installation, because the cables travel along the drum as they wind on or unwind off, there is only one point in the car and counterweight travel where they exert a vertical pull. At all other places in the shaft a side pull is applied to the car and counterweights. The effect as applied to the car is indicated in Fig. 3, which shows that if the cables pull vertically on the car at the top landing, at every other position there is a side pull. This is also true for the counterweights. To avoid this side thrust in high-rise installations, a single spiral groove is sometimes used on the drum, and one-half of the drum is grooved right-handed and the other left-handed. One of the two car cables is attached to each end of the drum and the two counterweight cables at the center, as in Figs. 4 and 5. From these figures it can be seen that although the cables lead off from the vertical, one opposes the side thrust of the other and the result is a vertical pull on the car and counterweights at all positions of travel.

What might be considered as a transition in the design between the drum-type elevator machine and the traction type is an arrangement known as the drum-type traction drive. This machine uses a single spiral U-groove drum. The cables run from the car and are given 1½ or 2½ wraps around the drum; then they go to the counterweights, as shown in Fig. 6. The cables are not fastened to the drum in any way and depend upon their friction in the grooves to hoist the car or counterweights, as the case may be. In their operation on the drum the cables act as so many nuts having 1½ or 2½ turn threads on a bolt. As the drum turns the cables travel from one end of the drum to the other in much the same way a nut travels along a bolt. Since the cables bend in only one direction they have a long life under normal conditions.

This type of machine has the same objections as the winding-drum type; namely, a side pull is applied to the car in all but one position in the shaft, different lengths of drum are required for different heights of maximum car travel, and in high rises the drum becomes long and unwieldly. A limit switch is provided to stop the motor as the cables approach the end of the drum. Although the machine cannot pull the car on counterweights into the overhead beams, if for any reason the safety limits were to fail there would be a bad piling up of the cables at the end of the drum, which might result in serious consequences.

Traction-elevator machines, as they are generally known, may be divided into two general classes, full-wrap and half-wrap. In order to obtain sufficient traction between the cables and the traction or driving sheave, with U-shaped grooves, a secondary or idler sheave is used as in Fig. 7. The sheaves have parallel U-shaped grooves instead of spiral grooves as used on the winding drum of drum-type machines. In Fig. 7 the cables run from the car over the traction sheave down around the idler sheave, up over the traction sheave again and to the counterweights. This gives the effect of a full wrap on the traction sheave, from which this type of traction elevator gets the name, "full wrap."

From four to six cables are generally used, and the traction sheave always requires twice as many grooves as there are cables. To prevent excessive strains being

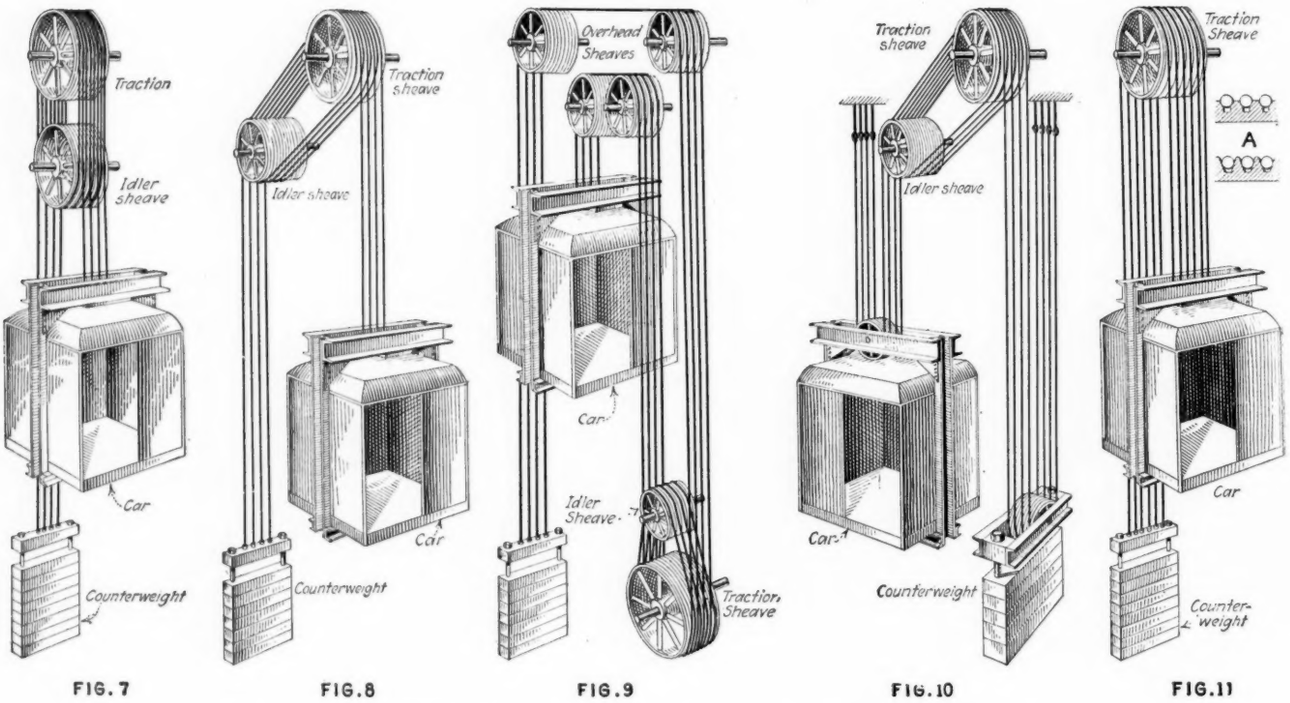


FIG. 7 FIG. 8 FIG. 9 FIG. 10 FIG. 11

Figs. 7 to 11—Different methods of roping up traction elevator machines

Fig. 7—Full-wrap 1-to-1 roping where the traction sheave spans the distance between the car and counterweight centers. Fig. 8—Full-wrap 1-to-1 roping where the traction sheave spans less than the distance between the car and counterweight centers. Fig. 9—Basement-type installation with 1-to-1 roping. Fig. 10—Overhead installation with 2-to-1 roping. Fig. 11—Overhead V-grooved type installation with 1-to-1 roping. This type of machine can also be used with a 2-to-1 roping.

set up in the cables, the sheaves should not be less than 28 in. in diameter.

With the traction type a standard machine can be used irrespective of the length of car travel. If the car or counterweights land on the bumpers at the bottom of the pit, the traction is lost between the cables and sheaves, so that neither the car nor counterweights can be pulled into the overhead work. Therefore, if the limit devices failed, the only thing that could happen would be for the car or counterweights to land and the motor keep running and turn the traction sheave in the cables until the power was cut off. There are cases on record where the sheave has turned for two or three hours in the cables with no more serious results than badly worn grooves in the traction sheave and wearing of the cables.

Where the diameter of the traction sheave is equal to one-half the width of the hoistway, the secondary sheave may be placed directly under it, as in Fig. 7. In installations where one-half the width of the hoistway is greater than the diameter of the traction sheave, then the idler sheave also serves as a deflector to lead the cables vertically down to the counterweights, Fig. 8.

Cable Arrangement on a Basement-Type Traction Machine

In most cases traction elevator machines are located overhead. When it becomes necessary to install the machine in the basement, a roping up arrangement is used similar to that shown in Fig. 9. This requires a somewhat similar arrangement of overhead sheaves as with the basement-type drum machine and also causes reverse bends in the cables. About twice the amount of cable is required for this installation as for the overhead, and the additional sheaves make the cost considerably more than for the overhead installation. Furthermore, the cable life will be shorter and the power consumption higher, consequently the operating expenses will be greater than for the overhead machine. For these reasons the basement-type installation should be avoided whenever possible.

Roping Up of 2-to-1 Traction Machine

In the traction-type installations so far considered, the speed of the car and counterweights is equal to the peripheral speed of the traction sheave. This is what is called a 1-to-1 roping, in that the car and cable speed are the same. Where it is desirable to use a direct traction-elevator machine, that is, a machine in which the traction sheave is mounted directly on the motor shaft, and a car speed is required that is lower than can be obtained with a 1-to-1 roping, a 2-to-1 roping may be used as in Fig. 10. This arrangement is also used on some classes of geared-traction machines, where very slow car speeds are required, such as on heavy freight and automobile elevators.

With a 2-to-1 roping the car speed is only one-half that of the rope speed. Instead of the ends of the cables being attached to the car and counterweights, as on the 1-to-1 roping, they are dead-ended to the overhead beams. From one of the dead ends the cables pass around an idler sheave in the car crosshead and then around the traction and secondary sheave, then around an idler sheave in the counterweight crosshead and to the second dead end, as in Fig. 10.

Since one-half the weight of the car and the counterweight is carried on the dead ends, Fig. 10, the loading on the traction and secondary sheave is only about one-half that for the 1-to-1 machine, Fig. 8, consequently a lighter construction can be used. From Fig. 10 it will be seen that the cables make three reverse bends. This results in a shorter cable life for the 2-to-1 than for the 1-to-1 overhead installation.

A type of traction machine that is coming into wide use is that known as the half-wrap, the roping scheme of which is shown in Fig. 11. In this type of installation the cables pass from the car over the traction sheave to the counterweights, so that there is only a half wrap of the cables on the sheave. The traction sheave has some form of a wedge-shaped groove which grips the cables by virtue of the wedging action between the sides of the grooves and cables. Two types of the grooves are shown at *A* in the figure.

This type of installation gives one-half the loading on the traction sheave that is obtained with the full-wrap machine for the same weight of car load and counterweight, consequently the former can be constructed considerably lighter than the latter. With the one-half wrap installation there are a minimum number of bends in the cables, which tend toward long cable life. This, however, is offset to a considerable degree by the pinching action of the grooves on the cables, but cable life is generally a little longer on the half-wrap machine than on the full-wrap installation. For the same capacity and speed the same machine may be used for any height of car travel. If the limit switches fail to function, the car or counterweights will land on the bumper, when the traction between the cables and sheave will be relieved and the cables will not be strained or pulled out of the sockets, as is likely to be the case for a drum-type machine.

As the grooves wear there is a tendency for the pinching action on cables to be reduced. This is not a serious factor in the machine's operation since sheaves have given 8 to 10 years or longer continuous service without experiencing any difficulty from wearing of the grooves.

Effects of Worn Grooves in the Traction Sheave

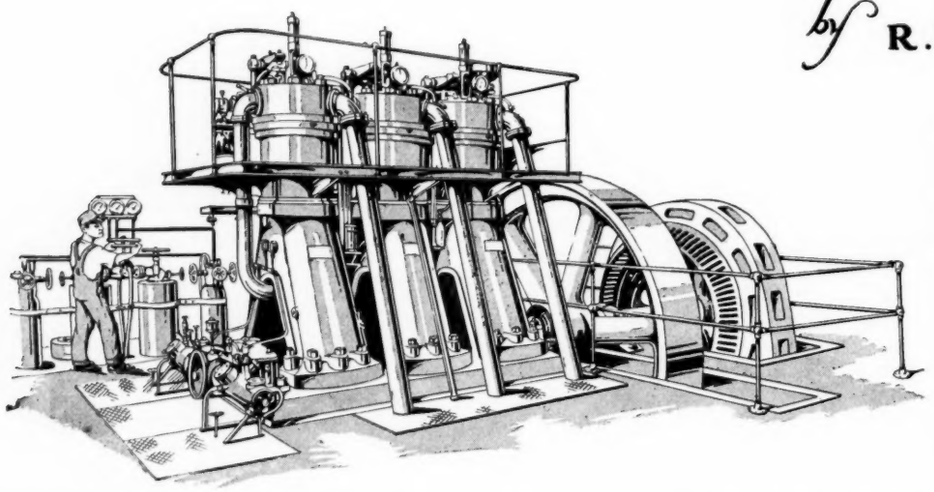
A feature of either the full-wrap or half-wrap installation that must be given careful consideration is the condition of the grooves. When one groove wears more than the other, the cable in the groove with the shortest periphery will have to slip a certain amount to have the same speed as the other cables. This slippage not only wears the cable, but it also wears the grooves and tends to make conditions worse. When the grooves become worn so that their peripheries are not the same length, they should be trued up in a lathe. This work is sometimes done by mounting a lathe tool and rest on the machine and turning the sheave with the motor. If the sheave is too badly worn, it will have to be replaced.

When the diameter of the traction sheave is less than one-half the width of the car in the half-wrap installation, a deflecting sheave can be used to guide the cables vertically down the shaft to the counterweights, as with the full-wrap installation, Fig. 8. The limit of deflecting the cables off the sheave is about 45 deg. from the vertical. When sufficient span cannot be obtained in this way, such as with wide freight cars, it will be necessary to use a full-wrap installation.

There are many other schemes that have been used in roping-up elevator installations, but those given in the foregoing have come into most common use and will include probably over 99 per cent of all electric elevators in use.

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Keeping the Engine Cooling System in Proper Condition

THE necessity of furnishing a suitable and ample supply of cooling water to a Diesel engine is not fully understood by all. For the most part, the difficulties in Diesel operation that are reported may be traced to improper cooling, in face of the fact that no internal-combustion engine can be expected to give good service if its cooling system is not properly cared for. It is much easier and decidedly less expensive to remove the scale-forming ingredients from the cooling water, than it is to remove scale from the water jackets of the engine, or to replace or repair parts injured on account of poor cooling.

Let us keep in mind that the cylinder liners and pistons of a Diesel engine are subject to high temperatures, being exposed to heat of combustion as high as 2,700 deg. F. In designing a Diesel these high temperatures are carefully considered and a lubrication system is provided by which the cylinder liners and pistons are easily lubricated, provided suitable lubricants are supplied and the liners and pistons are properly cooled. Without adequate cooling the lubricating oil adhering to the upper end of the liners evaporates faster than it is applied. This causes the piston to run dry, resulting in excessive friction and wear. If this condition is allowed to continue, there is danger of scoring the cylinder liners and possibly seizure of the pistons. A proper cylinder and piston cooling avoids all this in a simple and effective manner.

Excessive Lubrication Is Bad

The belief that an extra quantity of lubricating oil supplied to the cylinders will properly counteract the poor cooling of the liner is decidedly a fallacy. If the cylinder liners are supplied with excessive quantities of lubricating oil, the oil will carbonize and will drip from the cylinders into the crankcase, thereby contaminating the crankcase oil with carbon. Over-lubrication will "gum up" the piston rings. There is no easier method—in fact, there is no other method—of overcoming the bad effects of improper cooling of liners and pistons than to keep the water jackets free from scale. Even a thin scale has a harmful effect.

The temperature of a Diesel cylinder head varies widely, all the way from stone cold to a high temperature when the engine is carrying a full load, and even when properly cooled, this alternate heating and cooling cause expansion and contraction of the cylinder heads, setting up stresses in the material. If, by reason of the accumulation of mud and scale in the water passages, the cylinder heads are not properly cooled, these stresses increase beyond the normal limits, finally causing cracking of the heads. It is unsafe to use a cracked cylinder head on account of the danger of water leaking into the cylinder. Cylinder heads are too expensive to be allowed to scale up, although this is the condition in many plants.

Piston Must Be Cooled

Proper cooling of Diesel pistons is another important item. The heat absorbed by the piston top during the combustion of the fuel oil can be dissipated only into the cooling water. If the piston top is not directly water cooled, the heat absorbed has to pass through the liner into the cooling water. If the liner is heavily coated with scale, the heat of the piston is not dissipated readily and a hot piston will result, causing scoring and seizure.

The exhaust valves of a Diesel engine are subject to the same alternate heating and cooling effects as the pistons. They must be effectively cooled, otherwise the stems become hot and will stick in their guides. In large engines, even the valve disks or heads are water-cooled to prevent warping and cracking. Ineffective exhaust-valve cooling will result in leaky valves.

If it is considered how easily and cheaply a proper cooling system for a Diesel engine can be supplied, failure to do so is certainly poor economy. Excessive friction and consequently loss of power is the result of poor cooling that leads to excessive wear of the liners and pistons. The scoring and sticking of a piston may cause a buckling of the connecting rod and an overstraining of the connecting-rod bolts. There are records of serious oil-engine damage directly traceable to overstrained connecting-rod bolts caused by sticking pistons. There is no doubt that the maintenance cost of the engine may be kept to a minimum where the scale-forming impurities contained in the

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cooling water are removed before the water enters the engine. In other words, the only guarantee of successful Diesel operation is the provision of an efficient cooling and water-softening system. Cooling water may contain the following objectionable impurities or foreign matter: Mud, sand, silt and oil in suspension.

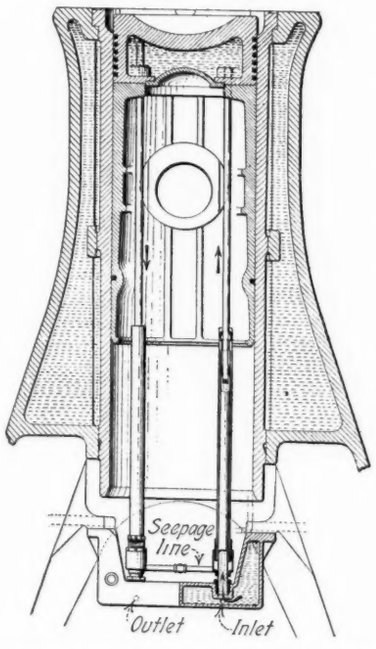

Fig. 1—Piston cooled by water through telescopic tubes

Mud, sand or silt, if present in the water in considerable quantities, may settle out in the water jackets and consequently impair the engine cooling. This kind of foreign matter is easily removed by passing the water through a settling basin before it is pumped through the engine.

All water, with the exception of rain water, melted snow and distilled water, contains some dissolved minerals. If such water becomes heated, some of its dissolved mineral—the temporary hardness—begins to precipitate as scale before the boiling point is reached, while other minerals—the permanent hardness—will not drop out of solution unless the water is boiled and thus evaporated. The carbonates of lime are the principal minerals of the temporary hardness, while the sulphates of lime and the carbonates of magnesia are those of the permanent hardness.

What Makes Water Hard

Water is classified as soft and hard, depending on the amount of dissolved minerals. It may be so hard—that is, so saturated with dissolved minerals—that it cannot keep any additional minerals in solution at the given temperature. Such water has reached its saturation point, which varies with the temperature. Cold water can keep a greater amount of mineral in solution than warm water. If water saturated with mineral becomes heated, it begins to precipitate the minerals as scale, regardless of what kind of mineral it contains. Water having a large amount of minerals in solution is called "alkali water" in the arid regions of the Western States. Fortunately, most of the water found in nature contains only a small amount of dissolved minerals and is far from its saturation point. Here it may be mentioned that even alkali water can be used if the suitable cooling system is installed.

Considering first the minerals forming the temporary hardness: Carbonate of lime, or limestone, and carbon-dioxide gas form a bicarbonate, which is soluble in water. As nearly every spring and river water contains some carbon-dioxide gas, it also generally contains dissolved carbonates of lime. If this water is heated, the gas is driven off and the carbonate of lime is precipitated as scale. If the water contains only a small amount of temporary hardness, it may be heated considerably before it forms scale. However, if the water contains a comparatively large amount of temporary hardness, it begins to form scale even at moderate temperatures. Thus the nature of the water determines to what degree it may be heated inside of the water jackets without forming scale.

Now considering the minerals of the permanent hardness: Ordinary water containing sulphates of lime ("gyp water") or carbonates of magnesia will not deposit scale unless it is heated to its boiling point and evaporated. However, if the water contains such large amounts of minerals that it reaches its saturation point below the boiling temperature, it will form scale without boiling. Scale caused by sulphates is very hard and difficult to remove. It cannot be dissolved as can the scale caused by carbonates, and for this reason it is advisable to be careful when using water containing sulphates of lime for cooling purposes. Gyp water, like alkali water, can be used successfully if a suitable cooling system is provided.

Any oil in the cooling water will form a hard, tenacious scale on the hot metal surfaces of the cylinder liners and heads. This scale cannot be dissolved and, even when very thin, interferes seriously with cooling. For this reason oil should never be allowed to drain into the circulating water leaving the engine, in case the water is to be used again for cooling purposes. The water from the piston-cooling system, if the engine has water-cooled piston tops, often contains some oil. Therefore, the water from the piston-cooling systems should run to waste, or before it is cooled it should flow through a large basin where the oil will have time to separate from the water before being used again.

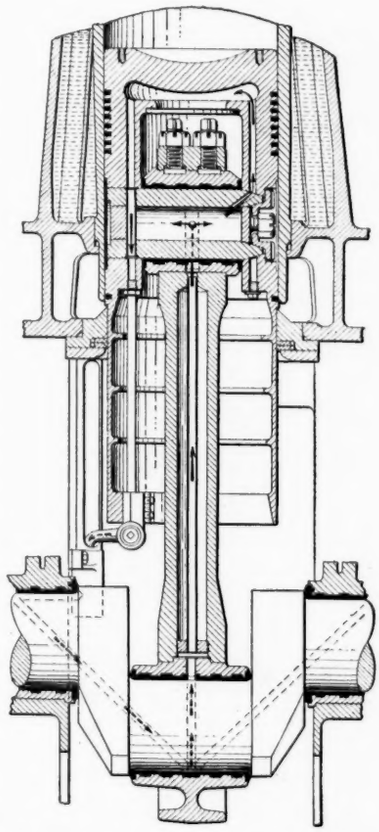

Fig. 2—Oil passing up hollow rod cools the piston

It is inconvenient to have the temperature range between the water entering and leaving the engine too great, say more than 35 to 40 deg. F., as then the amount of water circulated will be small and it will be found somewhat difficult to distribute the water evenly between the several cylinders. In addition sand and mud tend to precipitate in the jackets if only a small amount of water is circulated, that is, if the velocity of the water is low. Further, a large tempera-

ture range, resulting from too cool inlet water, causes the lower end of the liner to remain cool compared with the upper end and with the piston. In this case the piston expands more than the lower end of the liner. While the running clearance allowed is sufficient to care for the ordinary temperature differences between piston and liner, there is a possibility of a piston's seizing or sticking when the temperature difference between the incoming and outgoing cooling water is small.

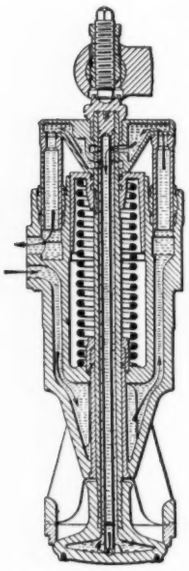

Fig. 3—Cooling of exhaust valve

When the engine is shut down, the cylinder walls, cylinder heads and pistons still contain a considerable amount of heat. This heat will cause the water in contact with the liners, cylinder heads and piston tops to heat up excessively and to precipitate scale if the water is shut off immediately after stopping the engine. In order to avoid this and also to prevent the oil film adhering to the inside surface of the liner from getting dry and hard, it is desirable to let the cooling water flow for a certain length of time after the engine is stopped. During winter, when the water entering the engine is very cold, it is proper to reduce gradually the quantity of cooling water flowing through the jackets after the engine is stopped, in order not to cool it too quickly. Cooling the engine too quickly causes undesirable stresses. Too slow a cooling, however, should be avoided. For this reason it is poor practice to reduce the water flow to such an extent that the water outlet temperature increases and the engine stays hot for a long period of time after being shut down.

If the water jackets are allowed to scale up, which is due to pure carelessness, the scale must be removed either mechanically or chemically by dissolving it.

As has been stated, the scale caused by water containing sulphate of lime, or "gyp water," cannot be dissolved. For this reason it is best not to use this kind of water at all, except as raw water for cooling the pipe coil of a closed cooling system.

In order to remove, or dissolve, the scale composed of carbonates, drain off the water and fill the cylinder and cylinder head with a mixture of water and hydrochloric acid (muriatic acid). The quantity of hydrochloric acid depends on the quantity of scale to be dissolved. A solution of 15 to 25, or even 50 per cent, acid may be used, bearing in mind that the stronger the solution, the more the tendency for the liquid to boil over. This solution should be allowed to stand inside of the cylinder and cylinder head until the development of gas ceases, which indicates that either the acid is used up or all the scale has been completely dissolved. This will take several hours. If necessary, supply once more an acid solution until all the scale is dissolved or at least sufficiently softened so that it can be flushed out with water. After the acid solution has been well washed out with clean water, a soda solution should be used to neutralize the acid which may have adhered to the metal. There are certain compounds that are substitutes for and will give better results than muriatic acid. [The next article will take up Lubrication.—Editor.]

Suggestions on Boiler Furnace Design

By C. M. GARLAND*

FURNACE temperature is all important since it is intimately related to the combined efficiency, the capacity developed and the life of the furnace lining. It is dependent upon the character of the fuel, the amount of air used for combustion, the rate of combustion and the design of the furnace.

Fuels low in moisture and rich in hydrogen, carbon and hydrocarbons produce high temperatures. Low-grade fuels high in moisture produce low temperatures and are often difficult to ignite rapidly.

The temperature developed by a given fuel in a given furnace is inversely proportional to the amount of air used per pound of fuel. As the ratio of air to fuel remains constant, theoretically, the temperature should remain constant without regard to the amount of fuel burned in the furnace per unit of time or without regard to the rate of combustion. Practically, the furnace temperature increases with the rate of combustion and the rate of increase may be made to vary widely, depending upon the furnace design.

High Furnace Temperatures Desirable

In general it is necessary to maintain the highest furnace temperatures possible consistent with the reasonable life of the best refractories obtainable. This is necessary for several reasons. In the first place, high temperature is necessary for the rapid ignition of the fuel. Rapid ignition is necessary to obtain rapid and thorough combustion in a reasonable furnace volume. In the absorption of heat by the boiler through convection—that is, by the passage of the gases over the heating surface—the smaller the weight of air used per pound of fuel burned, the less the amount of heat wasted in the flue gas for a given flue-gas temperature. Also, the smaller the weight of air used per pound of fuel, the smaller the number of particles of gas passing over the boiler-heating surface and the lower the flue-gas temperature for a given capacity. In addition to the foregoing the conduction of heat through the heating surface is directly proportional to the difference between the temperatures on the opposite sides of the surface, and the amount of heat absorbed by the boiler from direct radiation is proportional to the difference between the fourth powers of the absolute temperatures of the radiating and receiving surfaces.

It will be seen that all heat transactions occurring within the furnace and boiler setting will be dependent upon high temperatures for the greatest efficiency, and the only limit at the present time is the life of the refractories. Indeed the life of the refractories in a well-designed furnace may be a good indication of the economy of operation.

Some years ago the writer inspected a boiler plant

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and was told that the furnace linings had not been replaced in over six years. The owners were advised that this was a good indication that the plant was not being operated economically. A month's time spent in correcting the operation resulted in the saving of about 500 tons of coal a month, but the furnace linings burned out within the year. Where boiler furnaces are in operation twenty-four hours a day and loaded up to about the economical limit, it is seldom that the arches and side walls stand up for more than one year. It is, however, much cheaper to replace arches than it is to waste fuel in operating furnaces at low temperatures.

The problem in furnace design is therefore, first, to design a furnace that will produce the maximum over-all economy in the use of fuel, and secondly, to design it so that the lining will stand up for a reasonable period of time. The design of the furnace must necessarily depend upon the type of grate or stoker used for burning the fuel, upon the fuel itself, and in a measure upon the type of boiler installed. It is impossible to produce high over-all efficiencies unless all these items, which intimately affect the efficiency, are properly co-ordinated. Failure to co-ordinate all these factors results in poor power-plant economies. Instead of being able to obtain efficiencies up to 80 per cent and better in average installations and under test conditions, which should be easily possible with average fuels, efficiencies not exceeding 65 per cent are the rule.

Selecting the Stoker

The type of grate or stoker used depends upon the fuel, upon the load conditions and in a measure upon the type of boiler. Considering the stoker end of the furnace installation, it is obvious that if there are sudden large overloads or peak conditions, forced-draft stokers should be considered. From the fuel viewpoint and if the loads are fairly uniform, a natural-draft type of stoker may be preferred.

Where the fuel is a free-burning coal with comparatively small caking tendencies and contains large quantities of ash, the chain-grate type of stoker is best adapted for the fuel. If it is a plant in which maximum economy is of the first importance or the fuel is a low-grade product even though the load is uniform, in all probability it would be more desirable to use the forced-draft chain grate.

If, however, the coal is of the caking variety with a small or moderate amount of ash, it is probable that some type of underfeed stoker would be the more desirable either for uniform or fluctuating loads.

In the case of a fuel that has little or no caking tendencies and a moderate amount of ash of medium or high fusion point, it is likely that this fuel could be handled to better advantage in some V-type inclined-grate stoker. This would be particularly desirable if the load was uniform.

For large installations and where the plant is so situated that it cannot depend on a uniform supply of fuel of known composition, powdered fuel is to be considered. While there may be little advantage to be derived from the burning of powdered fuel, considered solely from the viewpoint of the boiler room, there is a decided buying advantage in being able to use practically any fuel that can be obtained upon the open market, and this may result in a material reduction of the coal bill.

One of the considerations of first importance in the design of the furnace and the selection of the stoker equipment is that of the stratification of gases. Gases like water have a tendency to stratify and flow in stream lines. Almost everyone has noticed a small muddy stream flowing into a large stream of clear water, in which the stream lines of the muddy water may be traced for miles in the clear water. This stratifying tendency of gases with certain types of stokers and grates is the cause of greater furnace losses than any other one element in furnace operation. It is, for example, the greatest disadvantage of the chain grate. In this type of stoker and in hand-fired furnaces the stratification of the air and the products of distillation where bituminous coals are burned, results in losses of from 5 to 20 per cent of the total coal burned.

Losses Caused by Stratification of Gases Underestimated

While engineers in general recognize that there is a large loss from this cause, the writer believes that these losses never have been given sufficient weight. In the first place, it is difficult to separate them as it involves an analysis of the flue gases for hydrogen, carbon monoxide and the condensable portion of the volatile products in coal, which are practically always present in furnace gases.

The effect of these losses was impressed forcibly upon the writer's mind by some tests which he made a number of years ago upon two return-tubular boilers located in adjacent settings and similar in every respect with the exception that one of them was provided with equipment for thoroughly mixing the gases over the grates. The boilers were fired by the same fireman and the same coal was used under each. Each was set about 30 in. above the grate and in the case of the one in which the gases were thoroughly mixed before coming in contact with the heating surface, the boiler and furnace operated smokelessly and there was a difference in economy of 19.6 per cent in its favor.

The design of the chain-grate stoker is such that stratification is unavoidable. In practical operation the air leaking past the bridge wall and the end of the chain results in a stream of gases rich in oxygen passing directly into the tube space. At the same time there is a stream of gases poor in oxygen and rich in products of distillation passing up from under the ignition arch. These two streams, one rich in oxygen and the other rich in products of distillation, never mingle in the furnace proper, and when they reach the boiler tubes they are cooled below the ignition point.

Building Up the Fuel Near the Bridge Wall

Attempts have been made from time to time to run the chain-grate stoker so that the fuel is built up near the bridge wall. The results obtained in the majority of cases have not been satisfactory either for the reason that the loss in carbon sent over the back of the grate offsets the loss due to stratification, or because the fuel accumulates to such depths that the draft is shut off and loads cannot be carried satisfactorily.

In the forced-draft chain grate the blast is supplied to the grate much more uniformly than in the natural-draft type and, what is of greater importance, the draft can be varied to suit the fuel-bed conditions over the different portions of the grate. The result is that, while stratification still occurs, the strata of air and

products of distillation are mixed more thoroughly and a much smaller percentage of air comes in between the bridge wall and the end of the grate. This is the reason why it is sometimes more efficient to use the forced-draft chain grate on uniform loads than it is to operate with the natural-draft type. The saving in fuel more than offsets the amount of power required to operated the forced-draft equipment.

Less Tendency for Stratification with Underfeed and V-type Stokers

In the case of the underfeed stoker the tendency for stratification is still less than in the forced-draft chain grate and in the inclined-grate stoker of the "V" type the tendency for stratification is even less than with the underfeed types. This is due to the fact that there is practically no chance for air to leak past the bridge wall and that the action of the grates, when fuels are used that are adapted to this type of stoker, insures a comparatively uniform flow of air through the grates and the fuel contained thereon. In addition to this the stream lines of air and the products of distillation coming off the fuel bed are given a twist, as it were, under the arch and the products from the front end of the grate pass over the products arising from the rear end of the grate, with the result that the inherent mixing action is much greater than in any other type of stoker.

As might be expected, this type of stoker, when used with suitable fuels, can be made to produce thermal efficiencies as high as any other type, assuming that the other type has not been equipped with special provision for overcoming the action of stratification. Unfortunately, however, this type of stoker requires considerable attention in every-day operation to obtain the best results, and is not adapted to the use of a wide variety of fuels.

In the case of the chain grate the design of the furnace is of the utmost importance in the economy of the installation. The furnace must be first designed to obtain proper ignition of the fuel on the grate, and with fuels containing a high percentage of moisture this is no small problem.

Radiation and Conduction Losses

To conserve the heat within the furnace and maintain the highest temperature possible when burning a fuel containing a large percentage of moisture, it is essential that the furnace losses be kept at the minimum. The greatest loss from the furnace outside of the sensible heat of the gases passing out of the furnace, which is of course a necessary loss, is that due to radiation and conduction. The loss due to conduction may be minimized by properly insulating the firebrick lining, and in fuels containing a high percentage of moisture, where the temperature is necessarily going to be low, it is both desirable and practicable to insulate the furnace lining. In addition to this the furnace should be so inclosed that only a minimum of the radiant heat of the furnace can escape to the heating surface of the boiler.

Of these losses, that by radiation is probably the least understood and it is the most important loss from the furnace, as it directly affects the furnace temperature, the boiler efficiency and the capacity. As set for in the foregoing, the radiation loss is proportional to the difference between the fourth powers of the absolute temperatures; that is, it is proportional to T_1 to the fourth power minus T_2 to the fourth power, in which T_1 is the absolute temperature of the furnace and T_2 the absolute temperature of the substance receiving the radiant heat. In the case of the radiation to the side walls and roof of the furnace, the loss is comparatively small since the difference in temperatures between the side walls and the furnace is not great.

Where the heat is radiated to the heating surface of the boiler, where the difference in temperature is great, the case is different. The absolute furnace temperature may be in the neighborhood of 3,000 deg. F. and the absolute temperature of the heating surface of the boiler receiving the heat in the neighborhood of 2,000 deg. F. The result is, that if there is a large area of heating surface exposed to receive the radiation from the furnace, up to 40 per cent of the total heat liberated in the furnace may be absorbed directly by the boiler. This radiant heat, it should be understood, has nothing to do with the heat carried by the gases. This heat passes through the gases and is absorbed by the boiler in the same manner that heat radiated from the sun is absorbed by the earth without being lost in space or affecting directly the temperature of the atmosphere. It is the effect of this radiant heat that has a most important bearing upon furnace design. If, in the burning of a high-grade fuel, the furnace is not designed so that this heat is absorbed by the boiler, it will be absorbed by the furnace walls, with the result that the temperature will rise and exceed the safe temperature for boiler refractories.

On the other hand, if this radiant heat is not utilized in the furnace where low-grade fuels are burned, particularly low-grade fuel containing high percentages of moisture, there will be difficulty in the ignition of the fuel and inefficiency and interruption to service will result.

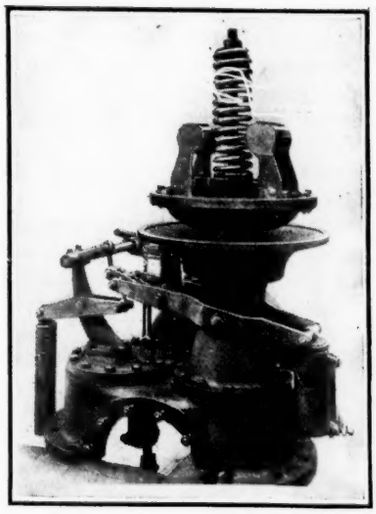
In a subsequent article, furnace designs for burning coal and wood refuse will be presented.

During the torpedoing or cleaning out of boiler tubes with the tube cleaner, the operator should take every precaution to keep the cleaner head moving through the tube at a uniform rate and avoid holding it too long in any one position. It is too often the habit of men doing this work to follow no regular procedure in passing the cleaner through the tubes, but to force it or let it lag as their fancy dictates. The result of such indifferent operation is that ridges of scale are left in the tube at points where the head was rushed through and in many cases serious injury to the tube wall at points where the head was held too long.

Sprinkler heads used in sprinkler systems for fire protection are often placed in locations where they are subjected to corrosive fumes, moisture or other agents which tend to corrode the heads and interfere with their proper condition of readiness to act in case of fire. Heads in such places may be proofed against corrosion by the application of the following mixture: 1 lb. boiled linseed oil, 1½ lb. rosin, 3½ lb. paraffin; add lampblack to color. All should be melted together and the heads dipped quickly with the temperature of the liquid about 180 to 200 deg. F. If the coating cracks or scales off, cut down the rosin content.

Adjusting Westinghouse Valve Gears in the Field

By L. LONG
Consulting Engineer, Sheffield, Alabama



INSTRUCTIONS should be obtained from the builder for authoritative guidance in adjusting valve gears of this type. The author describes a method developed from practical experience for general overhauling, as well as useful kinks in adjusting these gears. *Power* would be glad to receive from other readers articles based on practical experience.

IN ORDER to place in good adjustment a valve gear that has seen considerable service, it is necessary to inspect the entire mechanism and renew such parts as are worn undesirably, and otherwise make sure that everything is in good condition.

Before adjusting the valve gear, the emergency governor should be tested. When this trips at overspeed, steam is exhausted from the lower part of the steam cylinder connected to the auto-stop relay, Fig. 2. Steam forces this piston down, and therefore the auto stop-relay stem, to which it is connected, is forced downward. The oil ports below are consequently changed so as to raise the operating oil piston and close the primary and secondary valves. The automatic stop governor body will be found on the governor end of the turbine

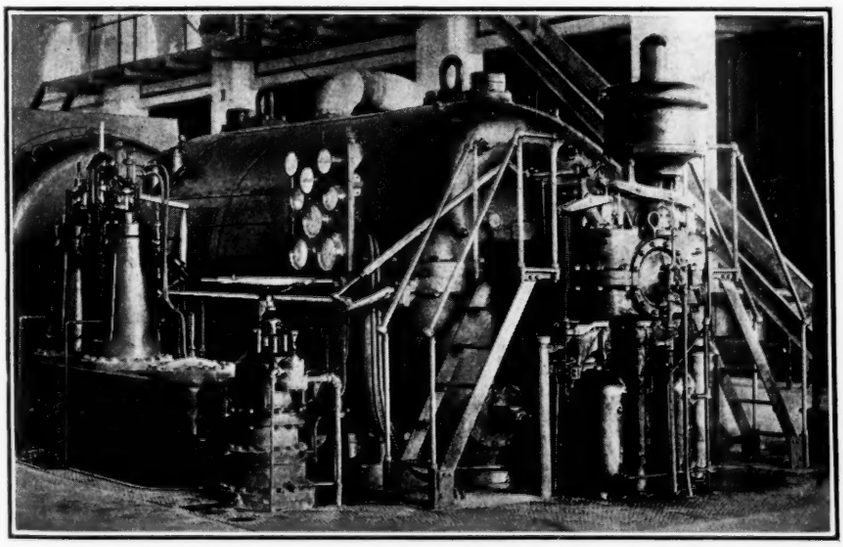


Fig. 1—Governor here operates both primary and secondary valves

spindle, this having been described in a former issue. By removing the cap it may be inspected easily. On the end of the emergency governor stop body will be found a small spring, which, being turned to one side, will disclose a small plunger that can be removed, and a spring tension nut can be seen. To move this nut from left to right one notch will increase the speed at which the auto stop operates, about 40 r.p.m. on a 3,600-r.p.m. turbine.

Test out the automatic stop governor in the following manner: Try out the plunger by hand to be sure no rust has formed to keep it from operating. With the turbine at slow speed, no load, saw a block to fit under governor housing and on top of the governor fulcrum lever (see Fig. 3). Bring the turbine up to speed, with a tachometer attached. When it shows 10 per cent overspeed, the automatic stop governor should trip, closing promptly the throttle valve, also the governor valves. If it shows more than 10 per cent overspeed, proceed as described and change the spring tension until it trips at the proper speed.

The governor weights lift the governor bronze collar *M* at the left of Fig. 3, to which the governor fulcrum lever is attached by the trunnion bolts *D*. The governor weights overcome by centrifugal force the tension of the main governor spring *H* in moving outward. The knife-edge *J* resting in knife-edge block, acting as a fulcrum, forces the governor table *R* upward. The through posts *K* lift the governor spindle sleeve *L* to the lower end of which the governor bronze collar *M* is attached loosely. A shoulder above and nut *O* below, hold it in position. A setscrew passes through the nut *O* into the sleeve to keep the nut from changing its position. A clearance of 0.005 in. should show between the nut and the bronze collar.

The flyballs or weights of the governor should not touch the governor spring at *H*, Fig. 3. If the proper parts are used and correctly installed, the weight arm will contact with the table at *R*, and will clear the governor spring, as also shown in the headpiece. If these conditions are not fulfilled, however, whether due to wear or improper parts, the cause should be investigated and corrected. Damage or improper operation would otherwise probably result.

Examine the governor-spindle bronze gear, see that it is polishing and not cutting; examine the turbine-spindle worm that drives it. See if the governor spindle is true. Bolt something for use as a stationary measuring point or telltale to the governor housing and use feeler gages between the telltale and the center of the pinion at the lower end of the governor spindle, below the governor-spindle bronze gear, Fig. 2. Turn the spindle so as to measure to several points along the pinion.

Should it be desired at any time to remove the governor spindle, remove the nut *G*, Fig. 3, lift off spring, remove keeper and nut on top of disk and the pin, if there is one. The spindle will then come out by forcing toward the bronze gear, or lower end.

The oscillating motion given the valve is produced by the rocking cam on the upper end of the pump shaft, Fig. 2. The relay plunger has spool-like pistons that keep the ports of the hydraulic oil cylinder closed when in control of the governor at constant load. They admit oil to the upper or lower side of the piston in the hydraulic cylinder, however, when the governor moves the plunger up or down.

The main valve and the train of mechanism connecting it with the governor, Figs. 1 and 2, should be so adjusted that this will not fail to close when running at no-load speed. In general the mechanism should be so adjusted that the floating lever and main governor lever, Fig. 2, should be approximately in horizontal positions when the governor is at the normal speed position.

With the turbine slowly rotating, the valve setting can be finally adjusted by means of the turnbuckle at *A*, Fig. 2. With the oil relay and governor connected, the oil pressure established and the turbine revolving slowly so as to get movement of the rocking lever (the governor weights being in their innermost or slow speed position), the turnbuckle *A* should be adjusted so that the oil operating piston is at the extreme bottom of its stroke. Then a setting should be made, so that if *A* be lengthened 1½ turns, it will cause a slight motion of the piston. In other words, the operating piston is not jammed down hard, but barely rests at the lower extreme position. If *A* were lengthened slightly, such as 1½ turns, the operating piston would then reciprocate, in response to motion transmitted from the rocking device.

The governor travel at this point of adjustment *A*

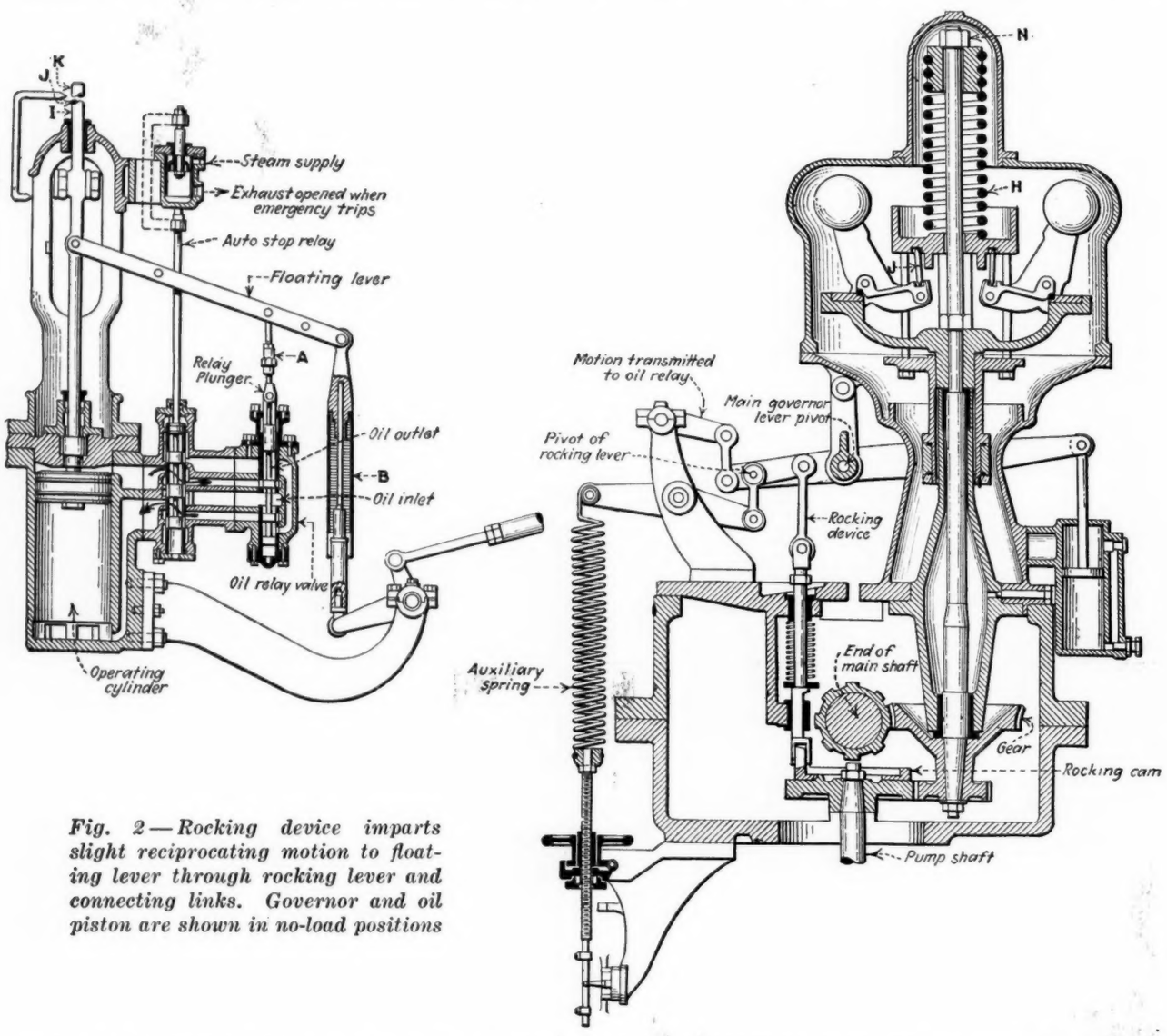


Fig. 2 — Rocking device imparts slight reciprocating motion to floating lever through rocking lever and connecting links. Governor and oil piston are shown in no-load positions

is ordinarily more than the actual relay travel at *A* as required to close the valve. That is, if a one-inch movement at *A* on the relay gives full valve travel, the governor would move the upper end of the plunger more, such as $1\frac{1}{4}$ in. from high-speed to low-speed position. As the turbine speeds up, the valve will therefore close somewhat before the governor reaches its entire wide-open flyball position. There is thus a

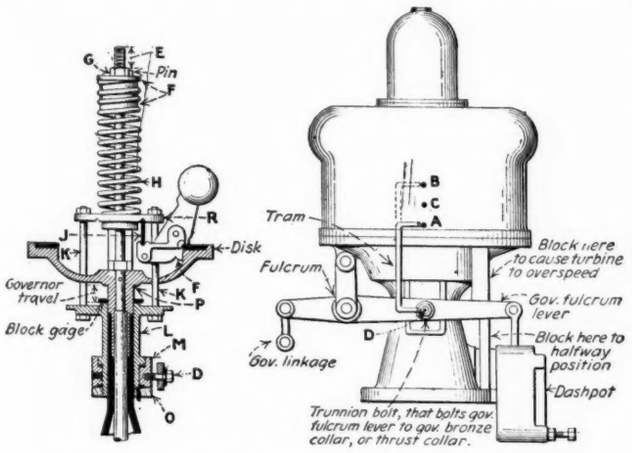


Fig. 3—The block above governor lever produces overspeed

safe margin to insure absolute valve closure, when set as described. Without such a margin valve closure might be preveneted as a result of expansion or wear in changing the linkage, which would allow the machine to overspeed.

A flexible link *B*, Fig. 2, is supplied in most gears between the governor and the floating lever. In case the load should come off suddenly and the turbine be subjected to a sudden rise in speed, the governor might pass somewhat beyond the point wherein the relay valve is closed. This flexible member allows some extra travel of the governor, so that excessive strain will not be placed on the floating lever.

Overhauling an Old Valve Gear

A special method of checking valve and governor travel may be found convenient, in overhauling an old valve gear. It might happen that some of the parts have been changed so that the extra allowance of governor travel is not present as it would be in a new gear. The governor spring tension nut *G*, in Fig. 3, should be removed so that the spring no longer restrains the weight. Before removing this nut, take the measurement or count the threads for the distance *E*, Fig. 3. The nut can then be returned to the same adjustment as before by using this measurement.

The governor weights may now be opened and closed by hand. The total valve travel is trammed at the left of Fig. 2. The full travel is now shortened by placing a block gage, Fig. 3, of $\frac{1}{8}$ to $\frac{3}{16}$ in., so that it shortens the governor travel temporarily by this amount, as indicated. This will prevent the governor balls from reaching their entire high-speed or wide-open position.

If the main valves are adjusted to the full closed position while the governor weights in their full open position are restrained a certain amount by this block gage, there will then be a safe margin of governor travel equal to the thickness of this block gage, to insure valve closure after all is assembled and the block gage removed. In other words, when the block gage is removed the governor will have $\frac{3}{16}$ to $\frac{1}{8}$ in. travel as a safety margin for insuring valve closure at no load. This point was discussed regarding valve gears generally, in the May 1, 1923, issue.

In testing the main governor, first tram the trunnion bolt *D* to *A*, Fig. 3, that attaches the governor fulcrum lever to the governor thrust collar, while at its lowest, or low-speed, position. Then remove the main governor spring, after having taken the measurements from the governor-spindle nut to the top of the governor spindle so it can be returned to the same position. Spread the governor balls to the wide-open position, taking care that the knife-edges still remain in the knife-edge block. With the same tram locate another mark on the governor housing *B*, representing the high-speed governor position. The distance between these two tram marks *A* and *B* gives the travel of the governor fulcrum lever as restrained by block gage.

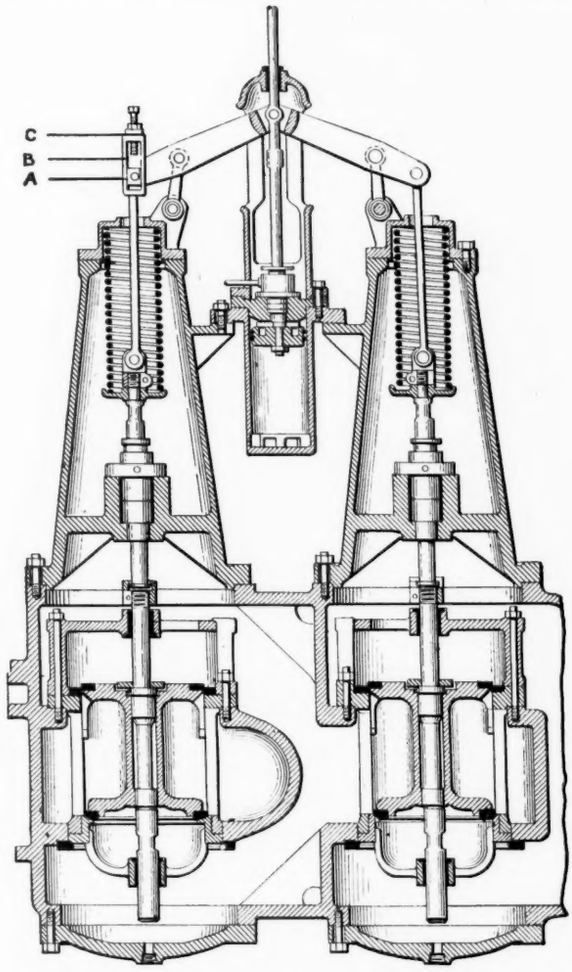


Fig. 4—Travel of secondary valve adjusted by setscrew C

Mark the halfway point *C*. Now go over all bushings and pins and remove the worn ones, replacing with new, until there is practically no lost motion between the fulcrum lever and the relay plunger.

With the lower block raise the fulcrum lever to the halfway position as by tram mark *C*. The linkage forks should move the plunger of the operating cylinder to the halfway point, with oil pressure on. This point may

be found by disconnecting the floating lever from the relay plunger and moving the latter to its extreme travel, both upward and downward, while the operating plunger is measured or trammed. Divide the travel distance of the operating plunger *I* to *K* in half, as *J*, Fig. 2.

Block Gage Insures Reserve Governor Travel

With the block in position under the fulcrum lever, which places it in halfway position, and all linkage pins in place, check the tramming from *D* to *C*, Fig. 3. Bring the oil pressure up with the auxiliary pump. Adjust *A*, Fig. 2, so that the governor valve travels upward to its half-travel position. The valve tram should now reach to halfway tram mark *J*, Fig. 2.

The valve may, however, from one viewpoint, be adjusted below the center and more nearly closed by an amount compensating for half the thickness of the governor block gage. (It would hardly travel actually this far on account of lost motion in the governor linkage.) For example, suppose a $\frac{3}{16}$-in. block gage is under the governor disk, the main valve travel is 15 in. and the governor fulcrum lever travel at *D*, 3 in., the ratio of travels being as 1 to 5. Then $\frac{3}{16}$ in. $\times$ 5 = $\frac{15}{16}$ in. This represents half the distance by which the valve may be adjusted beyond the true center of travel. The figures used are taken for convenience and do not refer to the actual travel of any governor or valve. The adjustment, however, is made as in the preceding paragraph, so a reserve of governor travel in the closing direction represented by the block gage will remain.

With the block gage in position under the governor disk, pull the governor weights sharply to their wide-open position; the steam valve should then seat promptly. Remove the wooden block, Fig. 3, from under the governor fulcrum lever, press the weights to their innermost, or low-speed, position, wherein the governor valve should travel to or almost to its wide-open position at *I*, Fig. 2, varying some on each individual unit. The gear should now be safe as far as the travel adjustment is concerned after the governor is assembled.

Putting the Main Valves in Good Shape

Before the turbine is brought up to speed, remove both the primary and secondary governor valves and see that there is 0.006 in. clearance between the valve stems and the valve-cage bores. This will insure the free operation of the valves. The valves themselves are double-seated. The valves are to be tested by pouring gasoline in the grooves around the seats and should show no leak. If they show appreciable leakage, the governor cannot be made to give perfect control. To grind the large valves, suspend them over the seat by a spring heavy enough to support the entire weight of valve and stem (do not attempt to grind them with full weight on the seats). Have the spring adjusted so it requires a slight pressure of the hand to bring the valve in contact with the valve seat; place abrasive compound on the seat and grind.

The primary valve is usually designed to carry about 80 per cent of the rated load, the secondary valve carrying about 20 per cent. A drop of six pounds pressure is allowable through the governor valve; that is, the steam pressure after passing the throttle should be six pounds more than the steam pressure after passing the governor valve, with the governor valve wide open.

To set the valve, bring the turbine up to speed, synchronize and build up the load on it until the pressure on the primary inlet gage shows within about ten pounds of the throttle pressure. At this point the secondary valve should come into operation. The point of opening of the secondary valve may be adjusted by means of the setscrew *C*, Fig. 4, which determines the distance *A* to *B* through which the lifting block travels without moving the valve. It is quite important that the secondary valve should not be brought into operation before the primary valve has reached its full opening, because if only partial admission is obtained on the primary valve when the secondary is in operation, the turbine will not be operating at its best possible efficiency.

Adjusting Speed and Governor Regulation

In regulating the governor for proper no-load speed of the turbine, remember that to screw down on governor spindle nut increases the speed. Loosen the nut to slow the turbine down. First loosen auxiliary spring, Fig. 2, to no tension and bring the turbine to speed. Measure no-load speed, and shut down for adjustment. Adjust the spindle nut until the turbine runs at the rated speed with no load, closing down the machine and moving the nut each time about half a turn until the proper speed is reached.

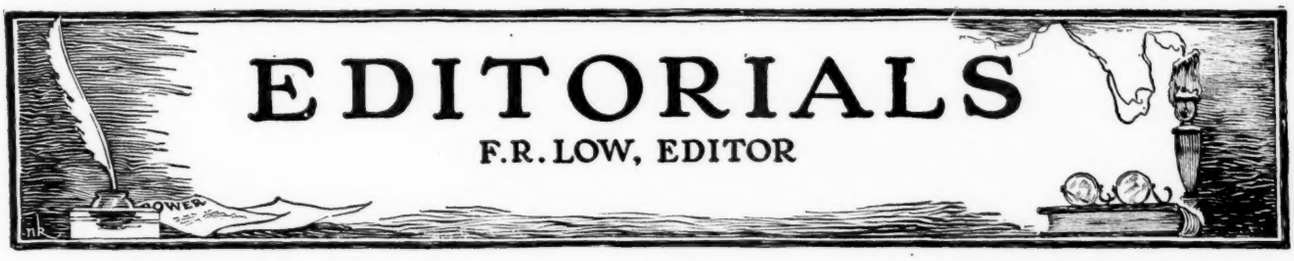
The speed variation between no load and full load is adjustable within limits and is usually set so that the change in speed between zero load and full load is 3 per cent when 80 per cent of full load is carried on the primary valve and 100 per cent on primary and secondary. If desirable to increase or decrease the speed variation, this may be readily done by placing more or less coils of the governor spring into active service. To broaden the speed variation, cut down the number of active coils and to make the governor more sensitive, vice versa.

If it is necessary to change the speed variation, remove the governor spindle nut *G*, Fig. 3, and spring. Screwed into the upper portion of the governor spring will be found the governor spring holding nut *F*. If the speed variation is too wide, back out the spring nut. If the regulation is too narrow or sensitive, screw the nut into the spring, thus placing less of the coils in active service. To manipulate the spring-holding nut, place it lightly in a vise, hook the upper jaw of a pipe wrench over the end of the spring and back it off a little. The regulation can then be tested and readjusted if necessary. The spring will screw on easily if caught by the wrench below the nut. It will then be necessary to recheck the no-load speed setting.

The following amounts of fuel oil were found by test to flow through a fuel-oil burner having a $\frac{1}{16}$-in. orifice. The oil used at the various temperatures shown was of 20 deg. Bé. gravity with a flash point of 220 deg. F. and at a pressure of 200 lb. sq.in. gage:

Temp., Deg. F.	Flow, Lb. per Hr.	Characteristics of Flame
60	340	Not atomized
110	440	Bad spark
153	375	Good flame
210	330	White and short
260	300	White, puffy
304	273	White, 2 ft. long, puffy

The total quantity of river coal recovered from the water courses in the anthracite region varies greatly with the condition of the coal market. The maximum recovery is about 600,000 to 700,000 long tons per year.



Test Results That Prove Little

TESTING, which is becoming of relatively greater importance, generally speaking, falls into two categories, one of which determines the performance under conditions as specified in design, and the other under conditions of actual operation. For some classes of equipment, such as alternators, actual duties may be performed under circumstances closely as specified in guarantees. Service tests therefore leave little doubt of the degrees of efficiency as paid for and delivered.

Where conditions are difficult of control, service tests are farther removed from those as specified in guarantees, which are frequently referred to as "ideal conditions." The manufacturer is vitally concerned in such performances, and also from a business viewpoint in those under different conditions as occasioned by operating limitations.

The ever-present temptation to display parade results as obtained under ideal circumstances, which distinctly mislead as to actual station performance, is likely to be viewed in a light of somewhat uncomfortable intensity. American station practice has at times been pointedly characterized by its search for and its adherence to truth. Cold figures that give a direct answer, may take precedence over more promising results, which are connected by a somewhat doubtful or unfavorable link with actual conditions.

The ultimate or basic efficiency, which is the average of operation over a long period, is, in the last analysis, an object common to both manufacturer and operator. The more intensive pursuance of this quest will undoubtedly tend to encourage more and more the exploitation of results representing bona-fide operation, as opposed to those representing unusual conditions.

Engineering Education

EMBRACING all the other arts and sciences, the science and art of education are perhaps the most important of all. Opinions differ widely as to the proper object of education. Outside of the colleges, at any rate, perhaps the most common idea is that education is justified only to the extent that it leads to success in the practical occupations of life as measured by financial and social reward. Another view is that education finds practically its only justification in the enlarged contribution to the common welfare that can be made by those educated. Still another view, and one that is widely held, particularly in college circles, is that the true object of education is the development of a mental and physical equipment that will enable its possessor to live a balanced and well-rounded life. There is something in each of these views. Each of these objectives is worth attaining.

The main idea underlying college courses in the "liberal arts" has probably been a composite of a desire to advance the student's material welfare, to increase his usefulness to the community and to enrich his emotional and intellectual life for his own personal benefit, with perhaps a slightly greater emphasis on the last. In professional schools, on the other hand, the emphasis has been rather upon developing the student's technical skill, so that he might succeed in his chosen profession, with the secondary object of enriching the community by adding to it men trained to grapple with its practical problems. The cultural element has been kept more or less in the background, although it has not been entirely neglected.

Two questions are worthy of careful consideration in connection with any system of education. The first is, What kind of results would be most worth while, all things considered? The second question is, To what extent are these results secured? In the field of engineering education these and many subsidiary questions will perhaps be answered by an extensive investigation now under way by the Society for the Promotion of Engineering Education, under a grant from the Carnegie Corporation. Headed by men deeply interested in education and provided with ample time and funds, this investigation ought to result in something really worth while, not only for the engineering profession, but also for the community in general, because, whether the public knows it or not, the mental equipment of its engineers is one of the prime factors in prosperity and national well being.

More Water-Power Development Restrictions

WATER POWER differs from most other natural resources in that it is self-perpetuating. Coal, oil, gas, mineral and other deposits, when once exhausted, are gone for all time. Timber over a period of years can be replaced, but water power is being continually replenished by a natural process of evaporation and condensation. The amount of water in any stream will vary, but over a period of time it will average about a constant value except as it may be affected by changes in the landscape and climatic conditions.

These facts seem to have been entirely ignored by Premier L. A. Taschereau of the Province of Quebec when he recently said before the Quebec Legislative Assembly that the province would fight to the limit any effort on the part of the Dominion Government to export hydro-electric power. It seems that the Premier anticipates that this action will cause the industries interested in this power to establish within his Province. How far such an attitude can be successful is probably best represented by conditions in Maine. Here the local government has opposed the exportation of power from the state, with the hope that such a procedure would cause industries to come to the power sources. However, there are few industries where

power is a dominating factor in their location today; raw materials, markets, labor, climate and transportation are in most cases of greater moment.

If large blocks of power are required and a steam plant can be built near a coal mine, power can be generated as cheaply as it can from many water powers. Furthermore, certain industries which a few years ago depended upon very cheap power to make them economically possible, have changed to where fuel supply is of far greater importance, and coal is something that Maine or Quebec does not possess, except as imported from without their borders.

The Quebec Premier seems to feel that power once exported will always be exported. This is something that is controlled by agreement and can be made any way the contracting parties may wish. Because St. Lawrence or Niagara power may some day be brought into New York City, is no reason why it should always come. As large loads are developed nearer these sources, the only economical thing to do would be to let this power go to these centers and supply New York from steam stations. So it is with Quebec; if it has excess water power that can be economically transmitted into the large industrial centers of New England and New York, then until such times as it may be required for her own industries it would seem like good business to obtain a revenue by allowing this power to be used for purposes outside the province, rather than retard its use by any restrictive legislation.

Preventing Electric-Power Losses

IT IS generally considered that when a leak occurs on an electric circuit, it soon develops into a defect that demands attention, whereas leaks may go on indefinitely on steam, air or water systems without causing serious trouble. There is considerable truth in this statement, but the fact that an electric circuit or piece of equipment does not develop trouble is no indication that power is not being wasted. There are many ways that power losses can occur in an electric system without giving external manifestations, but steam, air and water leaks will at least make a disagreeable sound or cause a condition that suggests attention.

One of the sources of electric power waste is in the feeders. These lines are frequently made too small, when at a small additional investment in the original installation they could have been made of ample size, with some capacity to spare. Increasing the size of conductors can frequently be done without enlarging the conduit, in which case the only additional expense is for wire, and will generally warrant the cost not only from the power saving that will result, but for the reserve capacity made available for future expansion. The cost of these losses will vary with the rate paid for power, but one kilowatt for one year of three hundred eight-hour days at five cents per kilowatt-hour amounts to one hundred and twenty dollars.

The application of motors is another prolific source of power waste. Improper alignment of motors to the driven machine, shafting out of alignment, belts too tight, incorrect size of motors, machinery that motors are driving not in good condition, motor running when machines are not in use, and lack of lubrication—all these are sources of power loss that may be present in any system unless a careful check is kept on operation. Since these conditions can be easily detected by simple tests on the input to the motors, there is small excuse for their existence in any plant. Some of the conditions can exist indefinitely without their presence being known unless tests are made, but the power waste is going on all the time the equipment is in service.

Overmotoring on an alternating-current system lowers the efficiency not only of the motors but of the whole system. Where the motor load has a power factor of fifty per cent, the losses in the system will be more than double those at one hundred per cent power factor to supply the same amount of power. Besides this it also represents an excessive investment in motor, transformer and generating equipment.

Wastes can and do occur in electric as in any other systems of power transmission, and it is up to the operating engineer to search these out and correct them. To the wide-awake engineer there will be as many problems of power economy in the electric system as there were in his steam plant, but they must be gone after in a little different way.

Auxiliary Apparatus For the Oil Engine Plant

THE absence of necessary auxiliary apparatus in the majority of oil-engine plants is noticeable. So convinced is the owner that the internal-combustion engine is a self-contained prime mover that he is apparently unwilling to supply anything in the way of auxiliaries beyond a cooling-water pump.

Although those localities where oil engines are most in evidence offer undesirable water for cooling purposes, the habit is to make use of this supply, stopping the engine occasionally to remove the scale from the cylinders. Scale is responsible for much of the grief met with in ill-organized oil-engine plants, and in view of the comparative cheapness of a pure water-cooling system, it is difficult to understand the attitude of the owner or operator who is satisfied to use a scale-forming water. Even when the amount of scale formed is small, it is advisable to install a closed cooling system, using nothing but rain water in the cylinder jackets and cooling this supply by raw water. The installation of sufficient pipe coils to care for the water cooling is small compared to the labor of scaling the engine jackets.

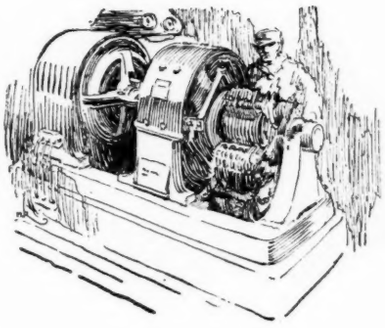
Purchasers of engines are not solely to blame. Manufacturers should not only suggest the use of proper cooling apparatus, but include it in the specifications as are the air bottles, oil pumps and the like.

The dearth of auxiliary apparatus extends to the oil-pumping arrangement. Although a float or pressure controlled electric pump is low in cost, the engineers of probably ninety per cent of the plants are forced to use a hand pump to lift the fuel from storage to the overhead or service tank.

The use of a motor-driven pump is solely for the engineer's convenience, but the absence of pyrometers in the exhaust line may have an important influence on the engine's behavior. It is universally conceded that the temperature of the exhaust gases is the best telltale on the condition of the unit, and pyrometers or even high-temperature thermometers are low in cost and fully justify their use.

Temperature regulation of the flow of the cooling water is in use in a number of plants, but should be given a wider application.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. Three prominent operating engineers have been invited to act as judges. The winners will be announced the succeeding month.

Limit Switches and Water-Level Indicator

For an isolated plant the water supply was stored in a large tank on a hillside above the plant. Water was pumped into this tank from a well about half a mile away by a triplex pump driven by a 20-hp. three-phase induction motor. Considerable trouble was experienced because the pump sometimes either emptied the well or overflowed the tank, or did both. As most of the pumping was done at night and the pump was about quarter of a mile from the main plant, there was no way for the attendant to tell how much water was in the tank.

After a few cases of trouble caused by the pump's running dry, it was decided to place an automatic cutout on the motor, to be operated by the lowering of the water in the well and by the action of the gage on the tank when it was full. The cutout switches must stop the motor just before all the water was pumped out of the well and they must also stop it when the tank was nearly full. While at the job it was decided to put in a set of visible signals so that the amount of water in the tank could be seen at any time.

The motor was equipped with a starting compensator similar to that shown at *A* in Fig. 1. When starting, the lever is first pulled over as far as it will go on the starting side. As soon as the motor reaches nearly full speed, the handle is quickly moved from the starting to the running side, where it is locked in place by the catch on the no-voltage release coil. The action of this coil is to hold the lever in the running position as long as current is flowing through the coil. Whenever the current is interrupted, the coil loses its magnetism and releases the catch that holds the lever over on the running side, and it instantly returns to the off, or neutral, position. The starter must be operated by hand in order to get the motor started again.

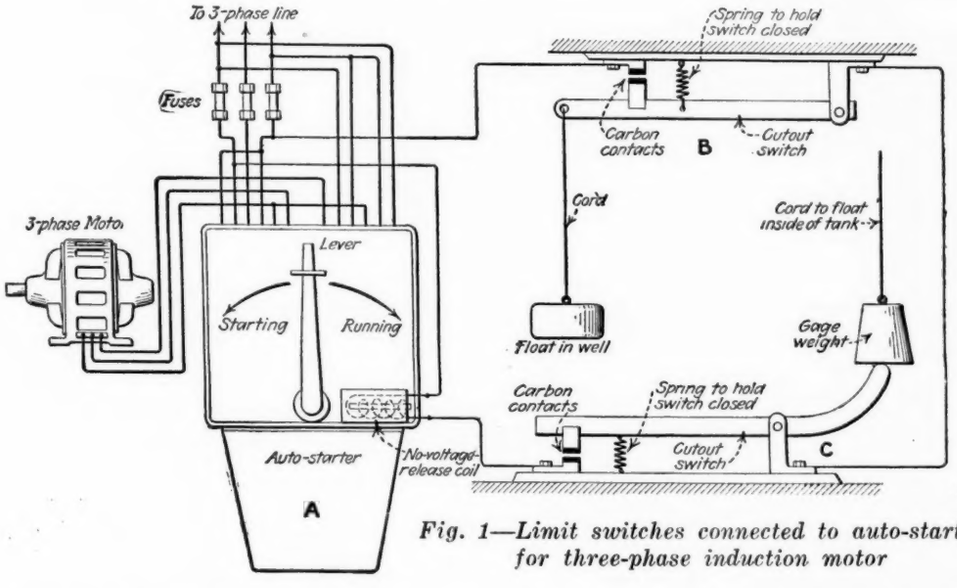


Fig. 1—Limit switches connected to auto-starter for three-phase induction motor

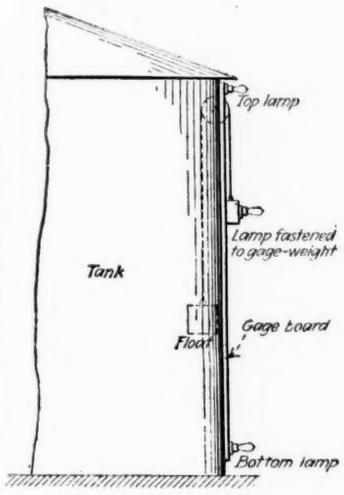


Fig. 2—Signal lamps on tank gage board

In the arrangement to shut off the water automatically whenever the water in the well was pumped down to a certain level, a switch *B* was connected in series with the no-voltage release coil. The blade of this switch was connected by a strong cord to a large float in the well. The length of cord was made such that just before the height of the water would allow the pump to take air, the weight of the float would open the switch and interrupt the circuit in the no-voltage release coil. This allowed the auto-starter lever to return to the off position and stop the pump motor. As soon as the water rose in the well, the cutout switch would automatically close and the motor would be in readiness to start again.

To shut off the pump motor automatically whenever the tank became full, a cutout switch *C*, was placed on the gage board of the tank and connected in series with the well switch and the no-voltage release coil. This switch was placed at the bottom of the gage board and arranged so that the gage weight would come in contact with the handle and cause it to open just before the tank was full of water, thereby opening the circuit in the no-voltage release coil and stopping the pump motor. As soon as the water fell in the tank the gage weight would leave the switch handle, the switch would automatically close again and the pump motor would be ready to operate.

The signal to determine the amount of water in the tank from a distance was arranged by the use of three electric lights, Fig. 2. One lamp was placed at the top of the gage board on the tank, another at the bottom, while the third was fastened to the gage weight. With the three lights arranged in this manner it was an easy matter to gage the distance between the gage lamp and the other two, which distance indicated the amount of water in the tank.

With the motor protected by the automatic cutouts, the chances for trouble due to the pump's running on air are eliminated. The visual signal is of great help to the attendants, as they can determine at any time the amount of water in the tank. With the tank protected from running over, an economy is effected in the saving of water and the unnecessary wastage of power due to the running of the pump motor. With both tank and motor protection the attendant can start the pump and leave it safely, with no fear of its running on air or the tank's running over. The motor will automatically shut off when all the water is pumped out of the well or when the tank is full.

The arrangements just described will work satisfactorily on almost any kind of an electric pump motor installation that utilizes an induction motor and an auto-starter or on any protective device that has a no-voltage release coil embodied in its circuit.

San Bernardino, Calif. FRANK HUSKINSON.

Queer Indicator Diagrams

Several years ago arrangements were made by an engineering instructor in a certain university to give his students practice in testing on a variety of engines in outside plants through the courtesy of the owners. One of the engines tested proved to be an interesting problem, by reason of the unusual conditions involved.

After collecting the basic information for the data sheet and having fitted up the apparatus for the test, we were ready to proceed.

Someone suggested taking a few preliminary diagrams to study the governor action, to which the instructor agreed. Some of the diagrams are reproduced herewith. Diagram Fig. 1 was taken at low speed with the engine throttled and the governor arm still against the stop; Fig. 2 was taken at a higher speed, with the steam valve throttled and the governor just beginning to act; Fig. 3 was taken with the speed increased to 240 r.p.m., steam valve throttled and the governor acting; Fig. 4 was taken with the engine running at full speed under control of the governor and handling the normal lighting load of the buildings and grounds.

The diagrams showed such unusual steam distribution that a problem was presented for the students to find an explanation and a remedy if possible.

On questioning the engineer, we learned that the engine had originally been installed in another part of the room; but a rearrangement seemed desirable and the engine and generator were placed in an alcove. In doing so it was thought necessary, on account of the short centers, to change the direction of rotation of the engine. The owners had secured a quotation from the engine maker for making the change, but thinking the cost excessive, they consulted a local engine builder, who told them it would not be necessary to pay as much, as he was willing to change the engine to "run under" at a cost not exceeding twenty dollars, so he was given the job. A new keyway was cut in the shaft at the same distance on the other side of the horizontal plane passing through the cylinder and crank at dead center. The governor wheel was reset and the engine ran under

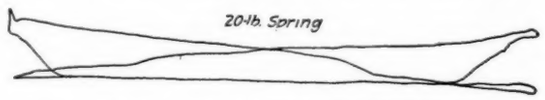


Fig. 1—Engine running "under" at low speed

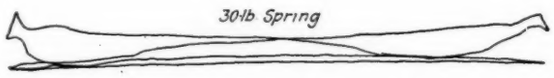


Fig. 2—Speed increased, engine running on throttle

Fig. 3—Speed increased to 240 r.p.m., steam valve throttled, governor acting

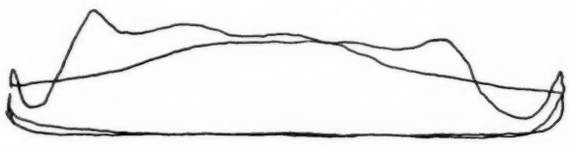


Fig. 4—Engine running at full speed under control of governor, carrying normal load

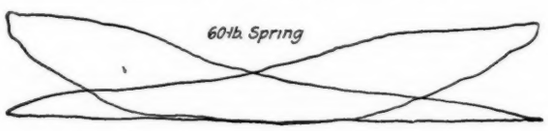


Fig. 5—Governor reset to original position, engine running over

as planned. The mechanic collected his pay and everyone seemed satisfied. This condition existed for about ten years prior to our visit.

Securing permission, we removed the key and reset the governor wheel in its original position; we then applied a rope Prony brake to the belt wheel and took diagram Fig. 5, which is a fairly typical one for a shaft-governor engine at this load. The engineer told us that the original estimate by the engine makers had included a new wheel and governor as necessary.

We were able to account for the peculiar diagram we had obtained, and laid out a typical diagram to illustrate the reason for the engine maker's quotation and to show the action of the governor in its position for running under.

This diagram is shown in Fig. 6 without reference to exact dimensions, as time would not permit us to go

farther into details without interfering with plant operation.

One of the fellows on the test made a theoretical estimate of steam used per horsepower-hour under the two conditions represented by diagrams Fig. 4 and 5 and found 53 lb. for "under" operation and 24 lb. for

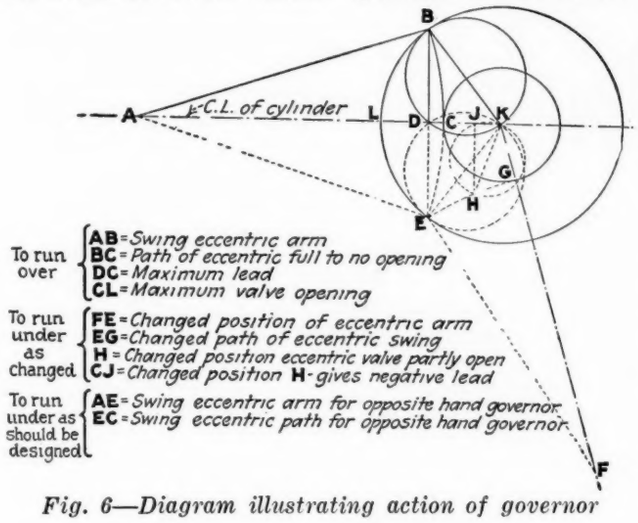

B
A
C.L. of cylinder
L
D
C
J
K
G
H
E
F
To run over
AB = Swing eccentric arm
BC = Path of eccentric full to no opening
DC = Maximum lead
CL = Maximum valve opening
To run under as changed
FE = Changed position of eccentric arm
EG = Changed path of eccentric swing
H = Changed position eccentric valve partly open
CJ = Changed position H gives negative lead
To run under as should be designed
AE = Swing eccentric arm for opposite hand governor
EC = Swing eccentric path for opposite hand governor

Fig. 6—Diagram illustrating action of governor

"over" operation, which showed that the plant had been operated very uneconomically from that point of view.

The findings of the class group were condensed and reported to the owners with suggestions that conditions could be remedied by either of two methods.

First—Secure an opposite-hand governor and wheel as originally advised by the engine maker.

Second—Replace the governor in its original position, change the wiring connections and brush setting to permit the generator to run in the opposite direction, and provide a suitable idler for the under side of the belt, running the engine over as originally designed.

Passaic, N. J. E. H. SEDGWICK.

Eliminating Some Troubles with Diesel Exhaust Valves

At times the exhaust or admission valve of an oil engine will chatter regardless of how strong the spring may be.

Every one familiar with gas and gasoline engines knows that some of these work very successfully with inlet valves that open automatically with the partial vacuum created on the suction stroke. This knowledge will clarify what I will explain later.

There were two 500-hp. Diesel units of the four-stroke-cycle trunk-piston type turning at 185 r.p.m. on a motorship which was making a trip around the world. They were the main propelling power.

The exhaust valves of these gave considerable trouble although for some time this was not felt to be of great importance.

When these engines were new, the valves opened and closed with a smooth and free action and were remarkably silent while they were running. After a few months of operation the valves began to chatter and rattle.

For some time we thought the springs were weakening with use, but upon taking them out and measuring their length we found that they were not taking a permanent set. When replaced with new springs, the action of the valves did not improve.

Once, while the engines were running, a valve fell off its stem into a cylinder, and when the piston came up it was crushed against the cylinder head. Fortunately, there was no sprung crankshaft or broken piston or cylinder head as the result of the crash.

The appearance of the exhaust-valve stem at the break indicated crystallization of the steel. It was a clean break like that of close-grained cast iron, and it was assumed that the crystallization was the result of the chattering and vibration of the valve.

Thereafter we began to think of this condition as something more than a troublesome noise of an inherent nature and possibly incurable without stronger springs or the help of the engine builder.

I will not resent the just criticism of experienced operating engineers who may say that our trouble was obvious. Frankly, I was a war-time engineer chief on a war-time ship with assistants strictly on a par with their chief and ship. Who discovered the trouble I cannot remember, but I would have a better memory had I been the one who did.

It developed that the slots in the breather pipes which admit air to the engine were too small, but were large enough to give the engine a full charge of air as long as they were clean.

No doubt the engine builders in taking indicator diagrams on test runs found the volumetric efficiency of the engine satisfactory, for new pipes would naturally be clean.

It never occurred to us until after the trouble was encountered that the clogging of these slots might cause the exhaust valves to fall off the stems. We did not associate exhaust-valve troubles with an air-inlet breather pipe.

Someone discovered that wiping these pipes only made them clean on the outside and that owing to the impurities in the air of the engine room, a portion of which was oil vapor, a black sticky substance accumulated in the slots and that the inrush of air would not remove it. When this was scraped out with an old hacksaw blade, the noise and clatter of the valves stopped.

The reason for this was that when the piston traveled down on the air-admission stroke the decreased area of the breather-pipe slots offered sufficient resistance to create a partial vacuum in the cylinder. This was great enough to pull the exhaust valve open against the tension of the spring, in a manner similar to the opening of an automatic inlet valve on a gas or gasoline engine. With the original area restored the air flow was more rapid and no vacuum formed.

I have already mentioned that these engines were of the trunk-piston type. The pistons were light as compared to the weight of the pistons, piston rods and crossheads of an engine of the crosshead type and inertia forces were not so great. We had been having a little trouble with a knock in the top end bearings which made necessary their keying up too often.

When the breathers were cleaned and the volumetric efficiency of the cylinders became normal once more, the pistons followed the swing of the crank on the suction stroke with less resistance, and the knock in the top ends stopped. Thus in clearing up one bad trouble we stopped another of lesser magnitude.

At the first opportunity we increased the size of the openings of the breather pipes and, needless to say, a material improvement was noticed.

Woodbury, N. J. A. B. NEWELL.

Comments from Readers

Direction of Flow in Sand Filters

Seeing in the issue of Dec. 30, 1924, page 1066, a description of a sand water filter, reminds me of one in which the material is identically the same as to size, position, etc. The water, however, is led in at top and taken off at the bottom, fine sand being at the top. The filter is washed by reversing the flow of water and letting it run to waste.

Personally, I thought the process was wrong, but the directions on the blueprint supplied by the maker says to filter from top and take water away from bottom. Is it possible that there has been a mistake made in this case, as the coarser material does not seem to be of much benefit, or is this a different type of filter?

Greenburg, Pa. L. SANDERSON.

High-Pressure Boilers in Isolated Heating Plants

In connection with the discussion at present going on in the correspondence columns of *Power* regarding the installation of high-pressure boilers in isolated heating plants of appartments, factories, etc., it seems to be one that is fairly easy of solution to an engineer who has the data available, although it would be rather an imposition to ask the manufacturers of such apparatus for the necessary prices, etc., if one were working up such a hyphothetical case without the intention of purchasing. There are probably plenty of consulting engineers who have such information available in their files.

It seems fairly evident that there is a size of building in which the fuel and light consumption is too small to warrant the continuous attention of an engineer sufficiently skilled to be safely put in charge of high-pressure boilers and an electric generating plant; an intermediate size of building where, with various combinations of heating and lighting load and fluctuations in wages, coal prices and lighting rates, it might under one set of conditions pay to let the janitor operate the boiler at low pressure and buy electric power and under others to operate a complete isolated plant; and a large enterprise where it would clearly pay the owner to furnish his own service or combine with neighbors to operate a block plant.

Such a schedule worked out for present conditions could be corrected for such future variations as seem reasonably possible, and such additional buildings as this would bring into the intermediate class could be equipped with high-pressure boilers and space left available for the installation of a generating plant should conditions later make it advisable.

Two rather intangible factors come in to prevent this being an open-and-shut mathematical solution: first, the advantage of having a qualified engineer in charge, in the improved operating conditions and maintenance of the plant with the least deterioration and at the lowest expense for repairs, and second, in proper supervision to see that competent men are secured to operate the plant and that they do their work properly, as it is only the exceptional man who can get along at his best without a little intelligent appreciation of his good work and the realization that poor work will not get by.

The experiences of Mr. Douglas and Mr. McVicker recorded in the Nov. 18 and Dec. 30, 1924 issues, respectively, are typical, and if owners could only be brought to realize that the power and heating system of a building consumes anywhere from one-third to more than its cost per year in fuel, wages, etc., they would not allow the architect to install equipment of which they have no direct knowledge without at least a check-up by an experienced operator. But as most of them have no idea of technical knowledge or what it costs in time and worry to get it, they refuse to pay the engineer one dollar for advice that would save them ten or one hundred later. H. D. FISHER.

New Haven, Conn.

Obsolete Examination Questions

I read with interest the article by Mr. Summers in the Dec. 23, 1924, issue on "Obsolete Examination Questions."

In this enlightened age is it not somewhat surprising to find anyone claiming to rank as an operating steam engineer complaining because he is required to have a working knowledge of the old-style weight-and-lever safety valve, also demurring because he must know something of the fundamentals and theories pertaining to steam engineering? Not so many years ago any handy man was considered good enough to look after a steam boiler and engine, little or no education was expected, and so long as the wheels were kept turning, no questions were asked, consequently the status and prospects of the handy man were not any too bright.

While it is true that some of these old-time handy men have risen to positions of trust and responsibility as operating engineers, it is also true that steam engineers as a body are only now beginning to emerge from the cloud that so long overshadowed them, and if the consideration and respect which their position demands have been tardily recognized, it is all the more gratifying to know that their efforts for just recognition have in some measure been successful.

Surely, it will be frankly admitted that higher education, better training and closer application have been the levers by which operating engineers have raised themselves from the position of handy man to one which not only does credit to themselves, but commands the confidence and esteem of their employers.

Examination papers are set to test our general knowledge of the why and wherefore of the varied equipment placed in our charge, and if in some instances the standard aimed at may seem high, there will be more satisfaction in passing the examination than if it was of a perfunctory nature.

With the educational facilities available today, such as night schools, textbooks and technical magazines, there should be no excuse for the engineer who has the ambition to succeed lagging behind. Whatever reading and study may be taken up, a thorough grounding in the fundamental principles of steam engineering is essential and will never come amiss. It will help greatly in straightening out many a knotty problem and pave the way to further success.

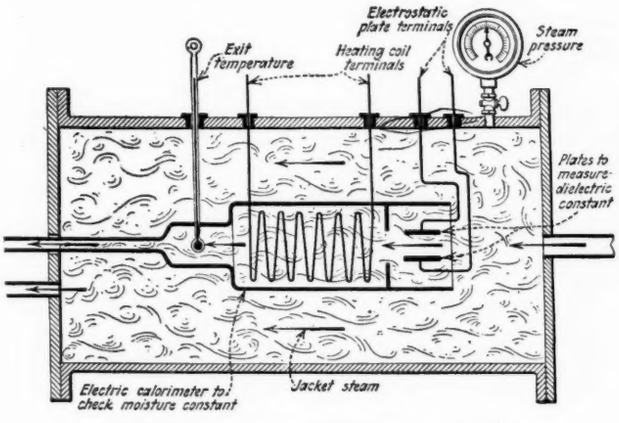
May I suggest to the writer of the article referred to, that, if he has any more examinations to face, he should remember that he is not only writing for a license but for a certificate of competency.

Vancouver, B. C. JOHN MORRIS.

New Method of Measuring Steam Quality

In *Power* for Oct. 28, 1924, there was an article on "Turbine Performance from Steam Quality Measurements," by N. L. Johnson, and I notice in the Dec. 16 issue a comment on this by E. Ogur.

These two articles refer to the use of the electric steam calorimeter which I invented and supplied to a good many users several years ago when I was directly connected with steam-turbine design. I developed the electric calorimeter in an effort to obtain results that would show the heat contents of steam as it passed through the various stages of turbines, and it has been used quite a good deal for that purpose. It is, perhaps, the only means available for determining accurately the quality of very wet steam. However, this calorimeter as well as all others depends, as to usefulness of results, upon obtaining a representative sample of steam, and this question of sampling is at the root of the difficulties in obtaining satisfactory results. I do not know of any way by which a sample of steam can be kept in its original condition while it passes through any kind of calorimeter placed externally to the turbine, but I have a suggestion that I should like to make to those interested in this line of work. I have talked about this with a few of my engineering friends in turbine manufacturing plants and in technical laboratories, but I think it worth while to publish the suggestion so that, if it seems to have merit, experiments can be made in research departments and technical laboratories.



Apparatus for calibrating terminals

My suggestion is that the electric properties of wet steam be investigated with a view to determining how the di-electric "constant" varies in steam of varying quality. The corresponding properties for air, and some gases, have been quite thoroughly investigated, but I do not know of any such work on steam.

If a small pair of terminals could be placed directly in successive steam passages where it is desired to determine the quality of the steam, and means provided for measuring the di-electric constant between the terminals, this might be a means of determining the quality, as indicated by the di-electric properties of the steam flowing between these terminals, the constant being assumed to vary with quality.

In order to use this method, it would seem to be necessary to calibrate the terminals, using an apparatus somewhat like that shown in the accompanying sketch. This consists of a lagged pipe in which would be placed an electric calorimeter with which the quality of the steam flowing in the pipe could be determined, the steam flowing through the calorimeter having first passed between and around the terminals which are to be calibrated.

Of course I do not know, and am not sure that anyone else does, how much variation there is in the di-electric constant of wet steam from one quality to another, but it seems reasonable to suppose that there is some variation. If so, a curve, or curves, for varying steam conditions might be produced which would be useful for the purpose mentioned. This method, if it should prove practicable, would obviate sampling and might give results of real use to steam-turbine designers. At any rate I make the suggestion for what it may be worth, in the hope that it will lead to research work along this line. Electrical insulation at high temperatures and in presence of moisture presents difficulties, but results of experience in this line are available.

An investigation of the electrical properties of steam might yield useful results, aside from those mentioned here.

Los Angeles, Calif. CARL C. THOMAS.

Type of Stoker for Lignite Coal

In the Nov. 25, 1924, issue G. B. Thomas asks for information concerning the burning of lignite on stokers. Having had seventeen years' experience along this line, I wish to say something on the subject.

In my opinion Texas lignite cannot be burned successfully on a chain-grate stoker. We have a number of boilers with a total of 100,000 sq.ft. of heating surface fired with this coal on stokers of the inclined type, which is very satisfactory. We also have about 50,000 sq.ft. of heating surface being fired successfully with underfeed stokers. With either type of stoker we are able to carry up to 200 per cent of rating, whereas with hand firing 75 per cent was about the maximum rating obtainable.

It has been my experience that natural draft is the best for the burning of Texas lignite. Most of the plants that I have visited use entirely too much air through the furnace.

The proximate analysis of Texas lignite is as follows: Moisture, 30 per cent; volatile, 30, fixed carbon, 30; ash, 10 per cent. Its heat value as fired is around 7,500 B.t.u. per pound. J. P. GREENWOOD.

Austin, Tex.

Questions and Answers

Conducted by

Franklin Van Winkle

Benefit of Covering Boiler Breeching

What benefit is derived from covering the breeching of boilers with a non-conducting covering? *L. G.*

Insulating the breeching materially helps to keep down the temperature of the boiler room, but where the breeching leads directly to the stack, the only additional benefit of an insulating covering is to improve the draft by obtaining higher temperature of the gases delivered to the stack. However, when an economizer is used or the breeching gases are employed for preheating the air supply to the furnace, much of the heat retained in the gases from use of a covering is returned to the boiler.

Action of Dashpots of Corliss Engine

What is the purpose and operation of dashpots on a releasing Corliss valve gear? *F. A. M.*

A dashpot plunger is suspended from an arm on the spindle of each steam admission valve to close the valve quickly and quietly when it is disengaged by the governor for the purpose of obtaining cutoff. In most forms of dashpots a partial vacuum is obtained in a "vacuum chamber" by the upward movement of the plunger while the valve is moved in the direction for opening, and when the valve becomes released from control of the wristplate, the fall of the plunger is accelerated by the pressure of the atmosphere. The vacuum chamber plunger is connected to the piston or plunger of a "cushion chamber" or dashpot proper, in which an air cushion is obtained, by means of which the plunger, in falling, may be brought to rest without shock.

Relative Value of Fire Tubes in Different Parts of H. R. T. Boiler

Which tubes of a horizontal return-tubular boiler are of most value as heating surfaces? *W. L. N.*

When the tubes are equally clean of soot, the greatest amount of heat is transmitted by those in which there is greatest velocity of the furnace gases resulting from the force of draft, combined with the form and arrangement of the back connection of the setting.

Usually, the more rapid deposit of soot in the upper half of tubes indicates a discharge of greater volume of furnace gases, but the accumulation of soot is accompanied by a reduction of efficiency in the transfer of heat, so that the best results may not necessarily be obtained from those tubes from which the gases issue with the highest temperature or velocity. However, when tubes are frequently cleaned, those that are no more than 8 or 10 inches above the bottom of the shell are of such little value that they may be better omitted than to take up space that is highly desirable for circulation of the boiler water and for cleaning the interior of the boiler.

Pumping Hot Water with Cold-Water Injection

Can hot water be handled by a pump if cold water is occasionally injected into the suction pipe? *T. J. H.*

When hot water cannot be handled by a pump because it becomes steambound, any method of reducing the temperature of the pump and suction water is beneficial. However, the trouble occurs because the pressure in the pump cylinder and suction chamber becomes reduced below the pressure at which water evaporates into steam when at the temperature of the suction water. Hence for obtaining the best result, the injection of the cooling water should be made into the cylinder or suction chamber of the pump or in the suction line close to the pump. Where cooling is found necessary to start or restart the pump and the initial temperature of the cooling water is constant, occasional injection of cold water cannot be depended upon for keeping the pump in operation, for, unless the cooling is continuous, the pump cylinder and suction chamber soon become heated to a point where they cannot absorb enough heat from the suction water to prevent vaporization, and the pump becomes steambound.

Making Hydrostatic Test of Boiler

In making a hydrostatic pressure test of a boiler, what precautions should be taken and, knowing the test pressure, could it not be obtained with an injector or a boiler-feed pump supplied with steam from another boiler? *T. J. H.*

A hydrostatic test pressure should be made with one and one-half times the maximum allowable working pressure, and the pressure should be under control so that the required test pressure shall not be exceeded by more than 6 per cent. For best control the test pressure should be obtained with a hand-operated boiler-test pump, for when the boiler is filled and closed up for testing, an injector or steam-driven pump is likely to injure the boiler from application of excessive pressure. For the purpose of making a hydrostatic test, care should be taken that when the boiler is filled with water there is no air pocket, for in event of a rupture parts of the boiler are likely to be projected with serious damage to life or property. In providing for a hydrostatic test, the safety valve or valves or each valve disk should be held to its seat by means of a testing clamp and not by screwing down the compression screw upon the spring. Special testing clamps, or "gags" for testing purposes, usually can be obtained of manufacturers of the safety valves. The test pressure should be determined by an accurate pressure gage with which the regular pressure gage should be carefully compared, and if not correct, the regular pressure gage should be immediately repaired or replaced by an accurate gage.

Hair Felt as Pipe Covering

As hair felt has the highest insulating value of any of the commercial pipe coverings, why is it not used more extensively? *T. S. B.*

The highest temperature to which hair felt can be subjected without disintegrating is about 250 deg. F., which is approximately the temperature of steam at the pressure of 15 lb. gage. At higher temperatures, especially when alternately moistened and dried, the material soon becomes brittle, and from repeated expansion and contraction from changes of temperature or when otherwise disturbed, the felting material is reduced to a dust that falls away from the upper side of a pipe, leaving it unprotected except by the original canvas or other covering. However, hair felt is an excellent non-conductor for insulation of brine and cold-water pipes and for an outer covering of asbestos and other more permanent coverings, provided it is covered with painted canvas or other waterproofing that protects the felt from moisture.

Conversion of Degrees C. to Degrees F.

What is the formula for conversion of temperature given in degrees Centigrade to degrees of the Fahrenheit scale? *G. B.*

In the Centigrade thermometer the freezing point of water is taken at 0 deg. and the boiling point of water at mean atmospheric pressure, at the sea level, 14.7 lb. per sq.in., is taken at 100 deg. In the Fahrenheit thermometer the freezing point is taken at 32 deg. and the boiling point at 212 deg., and the distance between these two points is divided into 180 deg. Hence 1 deg. Centigrade is equal to $\frac{180}{100}$ or $\frac{9}{5}$ of a degree Fahrenheit; or, conversely, 1 deg. Fahrenheit is equal to $\frac{100}{180}$ or $\frac{5}{9}$ of a degree Centigrade. Hence

$$Temp.\ deg.\ F. = \frac{9}{5} \times Temp.\ C. + 32$$

A handy rule for conversion of a Centigrade temperature to deg. F. is, Multiply the Centigrade temperature by 2, subtract a tenth and add 32. For example, to convert 60 deg. C. to Fahrenheit degrees,
$60 \times 2 = 120$; $120 - 12 = 108$; $108 + 32 = 140$ *deg. F.*

Sufficiency of Tank Outlet for Stated Discharge

We have a tank that is 10x10x12 ft. deep with 4-in. sewer outlet whose center is 2 ft. from the bottom. Will this outlet discharge the output of a centrifugal pump, 25,000 Imp. gal. per min. discharged into the tank, without overflowing the tank? *W. P. S.*

An inflow of water at the rate of 25,000 Imp. gal. per hour would amount to $25{,}000 \div (60 \times 60) = 6.944$ Imp. gal. per sec. As an imperial gallon is equal to about 0.16 cu.ft., the pump delivery would amount to $6.944 \times 0.16 = 1.11$ cu.ft. per sec. An outlet whose diameter is 4 in., or $\frac{1}{3}$ ft., would have an area of $\frac{1}{3} \times \frac{1}{3} \times 0.7854 = 0.0873$ sq.ft., and the velocity of discharge in a 4-in. pipe would have to be $1.11 \div 0.0873 = 12.71$ ft. per second.

The head required to produce this velocity, given by the formula $h = v^2 \div 2g$, would be $(12.71)^2 \div (2 \times 32.2) = 2.5$ ft. As the center of the discharge opening is 2 ft. above the bottom of the tank and the total depth of the tank is 12 ft., the total available head would be 10 ft. Allowing that the loss of head due to the orifice is one-half of the head required to produce the velocity in the pipe, the head available for overcoming pipe friction would be $10 - (2.5 + 1.25) = 6.25$ ft. In a 4-in. pipe, when the discharge is at the rate of 6.944 Imp. gal. per sec., or 416.6 Imp. gal. per min. $= 416.6 \times 1.2 = 500$ U. S. gal. per min., the loss of head per 1,000 ft. of pipe, given in hydraulic tables, is about 190 ft., or 0.19 ft. head per foot of pipe length. Accordingly, the length of 4-in. discharge pipe might be as great as $6.25 \div 0.19 =$ about 33 without the tank overflowing when receiving the output of the pump. By using a shorter discharge pipe, less head would be required for overcoming pipe friction and the same rate of discharge would be obtained with the water level carried below the top of the tank.

Advantages of Damper Regulation of Draft

What are the advantages of regulating boiler draft by a stack or uptake damper as compared with regulating the opening of the ashpit doors? *H. T.*

Regulation of draft by means of a stack or uptake damper admits of closer adjustment to the requirements and the draft is more easily controlled by a damper regulator operated by the boiler pressure. The disadvantage of regulation by the ashpit doors is that when the furnace draft pressure is reduced, the infiltration of air through the walls, cracks and joints of the boiler setting continues to greater extent than when the doors are open; also, when the boiler is thus operated, the products of combustion move in narrow channels and are less uniformly distributed over the heating surfaces. With damper regulation there is better plenum of the heated gases within the setting and a reduction of infiltration of air.

Gaging Steam Used by Tenants

We have several tenants who are supplied with steam through pipes of different sizes ranging from ½ in. to 1¼ in., and during much of the time the steam is drawn with valves full wide open. How can the amount of steam used be determined in such cases? *F. L. D.*

Where the amount of steam served is under control of the user, the amount drawn can be measured by a steam-flow meter that is adapted to the conditions, or if all of the steam is condensed by the user, the total weight of condensate would be the weight of steam supplied. A formula for determining the rate of flow of steam of given pressure through a given orifice or pipe of given size and length could not be applied except to determine the rate of flow under stated conditions. If the initial or supply pressure is constant, but the user varies the amount of his discharge valve opening, or has variation of pressure on the discharge side of his supply valve, there would be variation of the drop of pressure on the discharge side of a gaging aperture or in the exit end of the supply pipe, and since formulas for flow of steam through orifices or pipes involve the drop of pressure, any computation of flow based on such formulas would apply only to the times when the pressure drop was the same as the one used in the computation.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

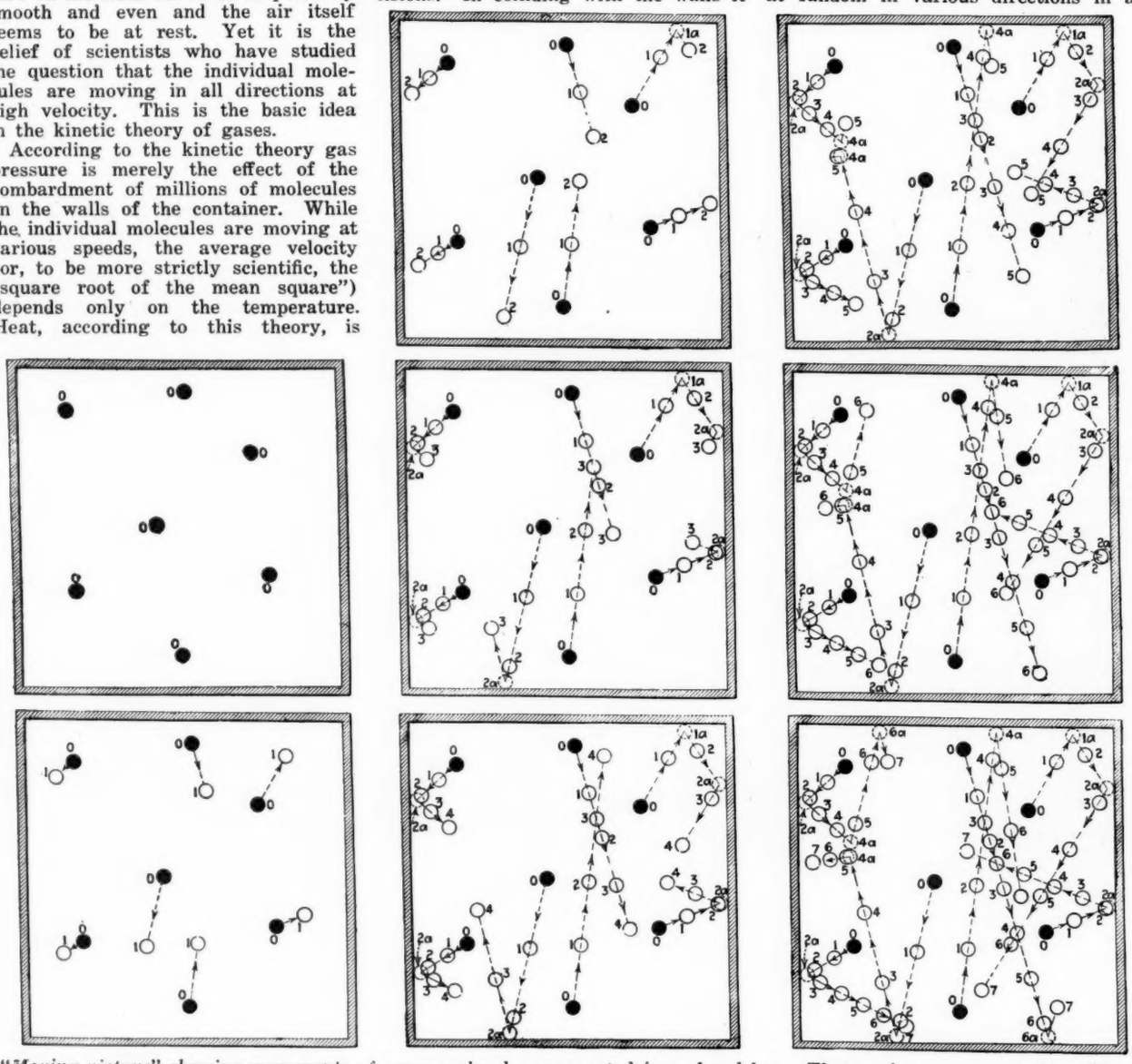
A Moving Picture of the Molecules

WHEN air or any other gas is confined in a closed tank, the pressure on the sides seems to be perfectly smooth and even and the air itself seems to be at rest. Yet it is the belief of scientists who have studied the question that the individual molecules are moving in all directions at high velocity. This is the basic idea in the kinetic theory of gases.

According to the kinetic theory gas pressure is merely the effect of the bombardment of millions of molecules on the walls of the container. While the individual molecules are moving at various speeds, the average velocity (or, to be more strictly scientific, the "square root of the mean square") depends only on the temperature. Heat, according to this theory, is merely the kinetic energy of the molecules. The total heat in a given volume depends not only upon the average speed, but also upon the total weight of all the moving molecules. Increasing the temperature increases the average velocity of the molecules and hence the pressure, which is the total force produced per square inch by the bombardment. Doubling the number of molecules in a given space without changing the average velocity (that is, at constant temperature) doubles the pressure.

In a perfect gas the molecule is assumed to fly freely at constant velocity and in a straight line between collisions. In colliding with the walls it bounces off at the same angle and with the same velocity, a condition approximated by a billiard ball striking the table cushion. When two molecules strike each other, they start off in new directions and with new velocities. This effect again is like that with billiard balls except that the billiard effect is somewhat complicated because the balls are not perfectly smooth and elastic. Collisions between molecules are assumed to involve no loss of energy, one molecule losing what the other gains.

To picture what happens, the accompanying "moving pictures" show possible paths for seven molecules moving at random in various directions in a closed box. The numbers 0, 1, 2, etc., represent the positions at successive equal and very small time intervals. For simplicity all the molecules are shown moving in the plane of the paper. Imagine this movement extended to three dimensions and the number of molecules shown multiplied by many billions, and you have a rough mental picture of what takes place in a tank full of air or other gas.



"Moving picture" showing movements of seven molecules segregated in a closed box. The numbers represent time elapsed

Tests of Vibration in Turbine Disks*

SEVERAL ruptures of disks due to vibration (see among others, *Power*, Vol. 47, No. 12, page 390, and *Engineering*, March 20, 1921, p. 231, "Turbine Troubles") have shown the absolute necessity of studying the vibrations of disks and determining under what conditions they are likely to occur.

In the following article it is proposed to describe the methods of testing that have been adopted by Brown, Boveri & Co. These methods have been applied to turbine disks furnished with their blades and ready to be mounted.

These investigations may be divided into two categories—static tests, which and dynamic, which have been executed upon disks in rotation, attached normally to their shafts.

Static Tests

For the static test the disks were attached to a mandrel and submitted to periodic attractions of an electromagnet, as shown in Fig. 1. By varying the frequency from 0 to 150 by means of a frequency transformer, the disk could be made to vibrate in different fashions in order to make apparent the mode of vibration. The disk was covered with sand, which, not being able to remain upon those portions of the disk that were in motion, collected upon the quiet areas, or nodes.

Fig. 3 shows a disk vibrating "en parasol," that is to say vibrating at the edges while the center remains fixed. This mode of vibration is characterized by the absence of nodal diameter.

Fig. 4 shows a combination of the mode of vibration "en parasol," and that of 2-nodal diameters. This combined vibration has not been obtainable except on very thin plates. It has never been produced on turbine disks.

In Fig. 5 the vibration is of one nodal diameter, that is, two quiet areas are arranged symmetrically about a diameter, as well as two moving areas about another.

The frequency of vibration depends on the temperature of the disk. An unequal temperature affects the distribution of tension in the disk and therefore its natural frequency.

The curve in solid line, Fig. 6, shows the frequencies of a cold disk, determined by a static test for modes of vibration from 0 to 6 diameters. The lower dotted curve of the same figure refers to the case in which the disk is warmer at the rim than at the center, as is the case in practice for the disks of the high-pressure stages. The comparison of these two curves shows that the heating has for effect an increase of frequency for the modes of vibration of 0 and of 1 diameter, and a diminution of the frequency in cases of from 2 to 6 diameters.

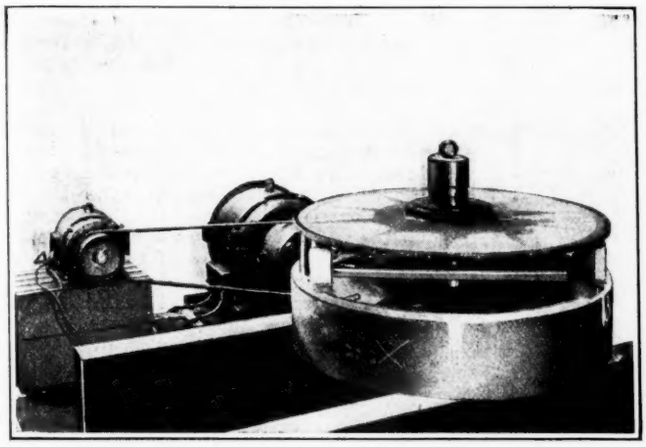


Fig. 1—Magnet pulls of adjustable periodicity vibrate stationary disk

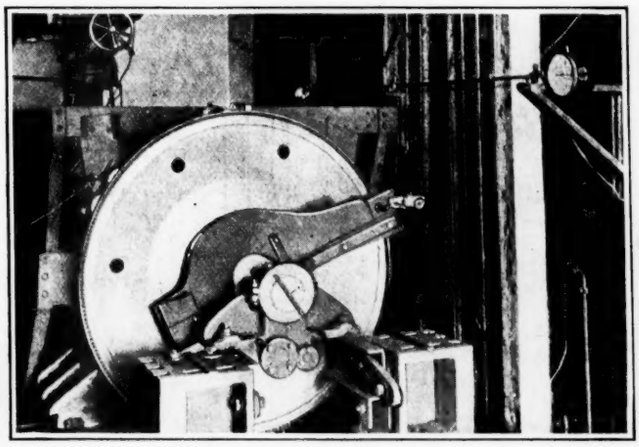


Fig. 2—Vibration recorded by device rotating with disk influenced by stationary magnet

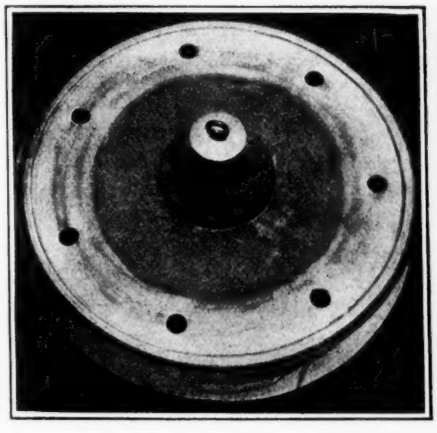


Fig. 3 — Vibrating motion comparable to opening and partly closing a parasol†

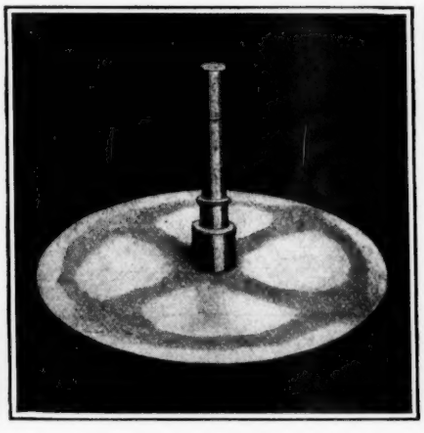


Fig. 4—Combined vibration of parasol type with that of 2-nodal diameters†

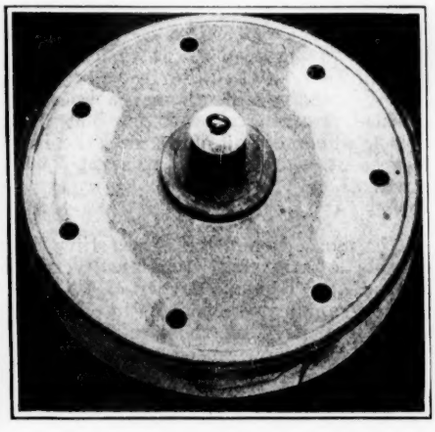


Fig. 5 — Two vibrating and two quiet areas represent vibration about 1-nodal diameter†

*Article from *Revue BBC*, December, 1923, page 231. Although these investigations were made some time ago, this is now particularly of interest as types of vibration were obtained which have not been reported as reproduced in this country.

†These three types of vibration are of particular interest since they were not obtained in the tests on turbine disks as described by Wilfred Campbell, an abstract of whose paper before the A.S.M.E. appeared in the July 15, 1924, issue.—Editor.

These frequencies, determined for the stationary disk, do not hold under the conditions of operation, for centrifugal force produces tensions in the disk which are not without influence upon its natural frequency. Centrifugal force imposes a tensile strength on the disk and in that way renders it more rigid. The frequency therefore becomes higher than that shown in the

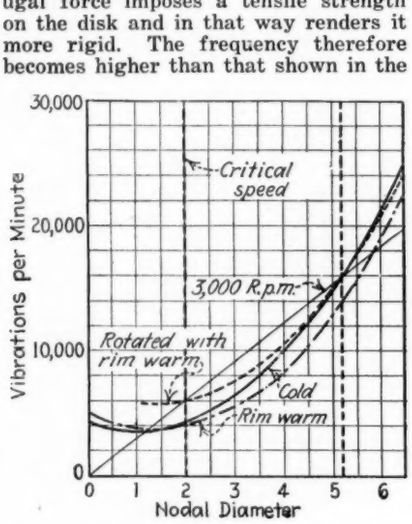


Fig. 6 — Nodal diameters obtained at various frequencies of magnetic pulsations, both stationary and rotating

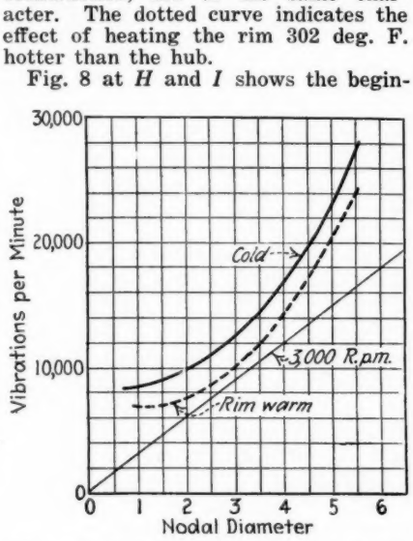


Fig. 7 — Reinforced disk either hot or cold, has no critical vibration at the rotating speed of 3,000 r.p.m.

stationary test; in other words, the disk behaves as though it were thicker.

The upper dotted curve in Fig. 6 shows by comparison the result of a dynamic test; that is to say, of a vibration test of a disk in rotation, of which the rim is warmer than the central part. This curve should therefore be compared with the curve of the warm rim obtained for the static test. It will be seen that the frequency has been augmented all along the line. A critical rotating speed is indicated where upper dotted curve cuts the line representing normal rotation at 3,000 r.p.m.

Dynamic Tests

The method employed for testing the wheels of turbines dynamically was created by Brown, Boveri & Co. A special apparatus, shown in Fig. 2, was constructed for these tests and installed in the overspeed testing chamber. The speed of the disk was varied from 0 to 4,600 r.p.m. The pressure of the steam jet, which in the case of partial admission may be the cause of vibration, is replaced by the action of an electromagnet with continuous current. This enters into vibration at different velocities, according to the number of nodal diameters. A movable arm, carrying an indicator, indicates and also measures the amplitude of the vibrations.

This measure is possible, because in the case of vibration with nodal diameters the deformation, variable for the disk in rotation, remains invariable in space. Fig. 8 shows, on a reduced scale, the vibrations recorded by the indicator for different numbers of nodal diameters. The velocities of rotation at which these vibrations are produced seem at first sight to be unrelated. It is found, however, that the frequency of the vibration is given by the product of the number of turns by the number of diameters, and may be represented as a function of the latter by a regular and continuous curve, such as that shown in Fig. 6 by the upper dotted curve. The curves of Fig. 7, which pertain to another disk of reinforced construction, are of the same character. The dotted curve indicates the effect of heating the rim 302 deg. F. hotter than the hub.

Fig. 8 at *H* and *I* shows the beginning and the dying out of vibration when the wheel is rotating at the number of turns corresponding to its natural frequency, the electromagnet being excited and shut off. Fig. 8 at *J* shows the vibration at four diameters at a velocity of 2,490 r.p.m., at which it begins; at *K*, 2,500 r.p.m., where it attains its greatest amplitude (this velocity corresponding to the natural frequency of the disk); then at *L*, 2,650 turns per minute, where the vibration is nearly suppressed and becomes irregular. The relative magnet position appears at *D*.

The danger of the production of vibration in the turbine depends on the one hand on the natural frequency of the disk, and on the other on the frequency of the impulses. The vibration is not possible, and the danger of rupture does not exist, unless the number of impulses corresponds to the natural frequency. The number of impulses that tends to produce a vibration is given by the product of the number of diameters by the velocity expressed in revolutions per minute. For a turbine turning at 3,000 r.p.m. the number of impulses will therefore be 6,000 for two diameters, 9,000 for three diameters, 18,000 for six diameters, etc. The number of impulses must consequently be represented in the diagrams, Figs. 6 and 7, by a right line passing through the origin.

The vibrations being impossible of production, except with an integral number of nodal diameters (a vibration with 2½ diameters would be inconceivable) it follows that the danger of vibration does not exist excepting if the oblique line representative of the impulses, and a curve of the vibration, intersect on the vertical corresponding to an integral number of diameters, as shown in the upper dotted curve of Fig. 6 for two diameters. There can be no critical speed at 5½ diameters, where a vertical line marks the intersection. This, however, indicates the 5-node vibration to be dangerous.

It will be noticed, that the points of intersection of the 3,000 r.p.m. line and the curve are displaced by an appreciable quantity, according as the disk is more or less warm. Between the extreme values there may therefore, exist conditions of temperature for which the point of intersection corresponds to an integral number of nodal diameters.

This explains why a turbine disk may vibrate under a particular load, although it will not vibrate under any other load, for at the given load the

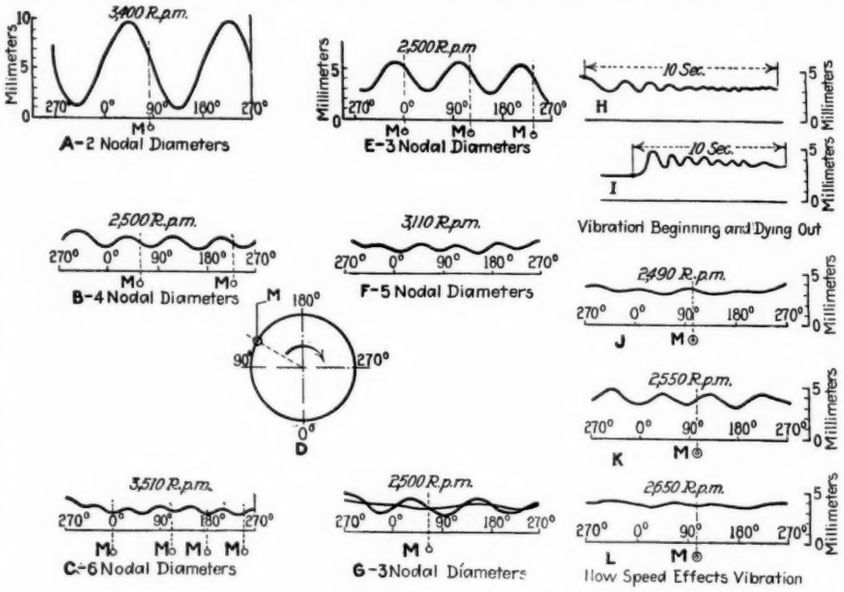


Fig. 8—Vibration recorded in rotating disk as illustrated in Fig. 2, excited by direct-current magnet (traced)

Pulsating magnetism produces vibration as recorded by curves *A*, *B*, *C*, *E*, *F*, *G*, *J*, *K* and *L*, the latter showing how vibration diminishes above the critical speed *K*. Magnet position is indicated at *M*. A magnetic shock produces waves as at *H* and *I*.

temperature may be at a point to excite the vibration.

The only way to avoid absolutely ruptures of disks from this cause consists, therefore, in constructing them in such a manner that the curve of their vibration does not touch at all the oblique line representing the impulses, as is the case for Fig. 7. Even the curve of the disk tested with a temperature of the rim of 150 deg. C., or 302 deg. F., higher than that of the center does not cut the right line at any point. Such great differences as this do not present themselves in practice.

These methods of tests for the static and dynamic conditions furnish the means to avoid with certainty such vibrations. At the same time they permit the determination by preliminary experiments, of the natural frequencies of the disk, which, according to the calculations of Professor Stodola, are possible for all forms of disks, and this is taking into account the conditions of temperature.

Operating Troubles with Centrifugal Pumps*

In spite of the inherent simplicity and reliability of the centrifugal pump it may exhibit troubles that are highly puzzling. Unsatisfactory operation may come at rare intervals with symptoms from which it is hard to determine the cause.

Turbine pumps should not only be filled with water, but on account of close clearances it is unsafe to bring them up to speed under any other conditions.

Small pumps with complicated piping may exhibit difficulty in picking up water, notwithstanding the fact that the air has been thorougly excluded. Such a condition is sometimes due to an air pocket which prevents the complete submersion of the impeller. Air-ejecting apparatus, if used, should be connected at the highest point, and also with any other places that would tend to form air pockets.

Pump glands in which sealing water is not being used, should be kept tightened to a greater degree than those that are primed. Corrosion of the impeller may result from long-continued air leakage.

Pumps sometimes will pick up water for a few seconds, as shown by the discharge gage and then lose the suction when the discharge valve is open. The reason for loss of suction generally is a large amount of air which is drawn in through the glands or suction pipe in some way.

Among the methods for testing air leakage are: (1) Running the pump and then closing the discharge valve, while examining for a loss of water; (2) examining the pump water discharge for air bubbles, especially if this discharges under water, such as in a tank; (3) by placing a mercury tube on the suction line which will show violent oscillation of the mercury if air is present; (4) by plotting graphically the head-discharge curve provided the water may be measured. If air is present, this curve will fall off rapidly as it approaches the closed-valve reading.

Air sometimes may be drawn in through the suction pipe, although the latter is entirely submerged beneath the level of the water. This is due to some extent to the vortex or whirling of the water around the suction pipe, thus forming an open passage to the air above. The author advises this has been noticed with a suction pipe 6 ft. below the surface. The cure lies in reducing the velocity of water in the suction pipe, either by adding a bell-mouth or tee, etc., or by drilling a number of holes into this pipe.

Foreign objects, such as pieces of wood, sometimes lodge in the impeller of the pump. This may often be detected by surging in the current supplied to the motor if the pump is motor-driven, or oscillation in the mercury columns of the Venturi meter if one is on the discharge. These oscillations are generally in the same period as that of the pump speed.

Multi-stage centrifugal pumps of the single-suction type ordinarily contain a balancing cylinder. The balancing apparatus requires the pressure of the water pumped in order to hold the impeller in its proper place. Sometimes the discharge valve may be opened too widely, so that this pressure is reduced to such an extent as to prevent proper action of the balancing cylinder.

When an air-exhausting apparatus is used for bringing water to a multi-stage pump, it should be connected to the first one or two stages supplied. This will prevent water from the high-pressure stage finding its way to the air-extracting apparatus when the pump is running.

Pumps are frequently connected to squirrel-cage alternating-current motors. The discharge valve should be kept closed until the motor is up to full speed. Otherwise, more power may be required in starting the pump than the motor will supply at low speed.

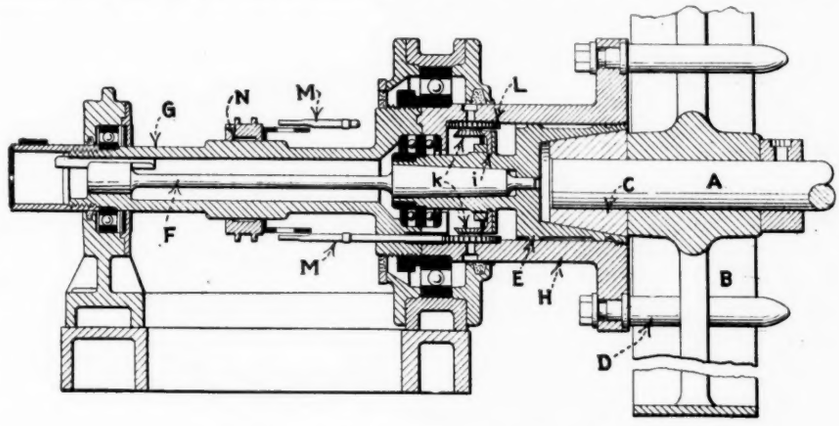
A pump may be run safely for short periods only with the discharge valve closed. When run longer than two or three minutes, over-heating of the water may result.

*Abstract of article, "The Operation of Centrifugal Pumps," by J. S. Pillans, in the Dec. 26, 1924, issue of *The Engineer* (London).

A Recording Torsion Dynamometer

A recent issue of the V. D. I. describes a type of dynamometer which may be readily applied to any driven machine to measure and record its power consumption, as a guide in determining the relative lubricating value and behavior of different grades of oil in service.

Referring to the section, power is applied to shaft *A* and is transmitted through the dynamometer to the driving pulley *B* from which the key has been removed to allow rotation about shaft *A*. The dynamometer is attached to the spokes of the pulley *B* by means of suitable fingers as indicated at *D*. The power is transmitted from the cone *C* of the coupling to the cup *E* which holds the inner end of the torsion rod *F* and is transmitted by this rod to the hollow dynamometer shafts *G* and *H* back to the pulley *B*.



Sectional view of torsion dynamometer

The "twist" of the torsion rod *F* is proportional to the turning moment and serves as a measure of the power consumed. It is transmitted to the small face gears shown at *i* and *k*. The turn of the smaller gear *k* is translated into a straight-line motion by the gear wheels *L* and the racks *M* in causing the ring *N* to slide a proportionate distance along the hollow shaft *G*. A suitable pencil mechanism operated by the movement of ring *N* draws a continuous record of this displacement on a strip chart, along which a second pencil draws a continuous zero or measuring line.

The paper is moved by a drum which rotates at a speed which is always proportional to the revolutions per minute of the torsion rod. The time is recorded electromagnetically every 10 seconds, which makes it possible to determine also the revolutions per minute from the charts. For the convenience of the operator an indicating tachometer, driven by a flexible shaft, is included. To minimize friction, ball bearings are used wherever possible and the principal parts are aluminum

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The United States exported to Newfoundland, according to *Commerce Reports*, power generating machinery (except electric) amounting to $41,517 from January to September, 1924.

Recent Publications

Power Plant Machinery; Details and Accessories, Vol. II. By Walter H. James and Myron W. Dole, of the Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., New York, 1924. Cloth; 6x8½ in.; 261 pages; 250 illustrations. Price, $3.

The first volume of this series dealt with the steam engine from the viewpoint of operation and design. The second volume, here reviewed, describes the construction of various parts of engines, turbines, compressors, pumps, air tools, etc., so that the student may grasp these details with the least expenditure of time. In the steam engine, for instance, practical methods of improving inherent efficiency are given and bearings discussed, showing details of lubrication, etc. This well-made-up volume will undoubtedly answer well the purpose for which it was intended.

Electrical Engineering. By L. A. Hazeltine, professor of electrical engineering, Stevens Institute of Technology. Published by The Macmillan Co., 64 Fifth Ave., New York City, 1924. Cloth; 4½x8½ in.; 625 pages; 364 illustrations. Price, $6.50.

This book differs from many others that have been written on the subject, in that at the very beginning attention is directed to the concept of energy instead of the fundamentals of electricity and magnetism. The first chapter is devoted to the basic ideas of physics which must underlie the electrical branches and shows the relation between certain mechanical and electrical conditions. Mechanical force is introduced as the space rate of change of energy, and five different results that can be produced by a falling body are illustrated —gravitational, elastic, kinetic, chemical and thermal. Another feature is the unification of different subjects as far as possible, by the use of comparison figures and tables and of like phraseology where analogous derivations occur. The work has been presented more as a college text than for self-study and is intended to be supplemented by the elaboration of an instructor.

A highly theoretical treatment of the fundamentals is given in the first part of the work, so much so that the author states in his preface regarding the chapter on alternating and transient currents, "that he does not expect a large proportion of the students to fully appreciate the significance of these mathematical developments, but he does feel that it is proper to carry a class through the basic derivation with care. A few students will follow the thought and the vision of the others may be deepened."

The treatment has been divided into 15 chapters, the first seven of which are: Fundamental physical relations; electric conduction; electrostatics; electromagnetism; alternating currents; transient currents and electric waves; conduction in gases and electrolytes. In the last eight chapters electrical measurements, machinery distribution and communication are covered. These last chapters are not so involved as the first and will in general be easily understood by the average student.

A Study of the Locomotive Boiler. By Lawford H. Fry. Published by the Simmons-Boardman Publishing Co., New York, 1924. Cloth; 6x9 in.; 151 pages; 31 tables and 32 illustrations. Price, $4.

The operation of the locomotive boiler and methods of testing it are here taken up. Information made available by locomotive testing plants is utilized so that the operation and testing may be presented in a practical and efficient form. Formulas and methods of analysis are the result of close contact with practical results. The work is planned so as to avoid the necessity for higher mathematics on the part of the reader, is well analyzed by means of subheads, and contains large readable illustrations which reveal the story of the locomotive boiler in a clear and efficient manner.

Switchgear for Electric Power Control. By E. Basil Wedmore and Henry Trencham. Published by the Oxford University Press (American Branch) 35 W. 32nd St. New York City. Cloth; 8x5½ in.; 335 pages; 202 illustrations; 15 tables. Price, $8.35.

In this book the subject of switchgear is treated of as it may apply to power-generating machinery. The control and switching equipment for electric motors has not been included. In the first five chapters the methods of automatically opening circuits are treated of, covering the subject from fuses used on high-voltage circuits to large-capacity high-voltage oil circuit breakers. The use of resistance and reactance in switching operations is covered in Chapter VI, and grounding of the neutral is the subject matter of Chapter VII. The next nine chapters are devoted to different systems of circuit and machine protection, followed by three chapters on the application of reactors in alternating-current circuits. One chapter is devoted to calculation of short-circuit kva. and another to the problem of handling small consumers on large power systems. The subject of Chapter XXI is, mechanical and thermal effects of load and short-circuit currents, and in addition to discussing this subject a number of busbar-copper and aluminum tables are given for current capacities and densities. There are five chapters devoted to switchboard panels and arrangement of switchgear, and the last three chapters deal with alternating-current instruments and equipment, outdoor switchgear, lightning arresters and surge absorbers.

The subjects have been presented from the user's point of view rather than that of the designer. Mathematics have been avoided almost entirely and the presentation of the material is made in an easily readable form. Although the book represents British practice throughout, it contains much to recommend it to those interested in power-plant switching equipment.

The Entropy of Steam (Entropie des Wasserdampfes). By Fritz Buerk. Published in German by Otto Spamer, Leipzig, Germany. Paper; 4½x7¾ in.; 47 pages; 4 tables and 11 illustrations.

Without resorting to the elementary, but avoiding intricate mathematical presentation, the author succeeds in giving a somewhat clearer interpretation of entropy and its application in determining the thermal efficiency of gas cycles, than is usually afforded by standard textbooks on thermodynamics. The many practical references and examples throughout the text are decidedly helpful. The introduction to the temperature entropy diagram and the useful purpose it serves in the analysis of all steam conditions up to the critical pressure and temperature is particularly commendable. Likewise the Mollier chart is explained and illustrated by using it to solve several hypothetical problems. Abridged metric steam tables by Mollier and Knoblauch for pressures to 60 atmospheres and metric tables on the specific weight and specific volume of superheated steam are included for convenient reference.

Electric Cables. By William A. Del Mar. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1924. Cloth; 9x6 in.; 208 pages; 58 illustrations; 30 tables; Price, $2.50.

Probably comparatively few of those connected with electrical development appreciate what an important part wire and cables are in the success of the industry. This the author brings out very forcefully in his book by the statement that each year in this country underground cables alone are installed to the value of about $25,000,000. This book deals with the design, manufacture and use of electric cables and has been compiled from a series of lectures delivered in the Moore School of Electric Engineering of the University of Pennsylvania, 1923-24. It was the interest evinced in these lectures by outside engineers that prompted putting them in permanent form.

The book is divided into 23 chapters and an appendix of 9 sections. Among the subjects treated are: Installation and splicing of underground cables; testing of cables and detection of faults; carrying capacity of cables; dielectric strength and insulation failure; design of cables for current and voltage; the present voltage limits in impregnated-paper cables; summarized history of published knowledge bearing upon the performance of insulation under electric stresses; etc. Although the author has resorted to mathematical formulas when necessary, for the most part the material is presented in such a manner as to make it of interest to everyone who may have to deal with electric cables.

Mid-West Power Show To Be Held in May

The united engineering bodies of Milwaukee, Wis., are announcing a Mid-West Power Show which will be held there from May 18 to 21 or during the week that the spring meeting of the A.S.M.E., the meeting of the American Society of Refrigerating Engineers and the Wisconsin State Convention of the N.A.S.E. are being held.

The large gathering of engineers directly interested in power equipment is expected to give great impetus to this power show, which will bring together the greatest array of power equipment ever assembled under one roof in the central part of the United States. Ralph H. Cahill is the secretary of the show and can be reached by addressing him in care of the Mid-West Power Show, City Hall, Milwaukee, Wis.

Brown-Boveri To Enter American Market

Brown-Boveri & Co., the well-known Swiss firm which has its headquarters in Baden, Switzerland, purposes to enter the American manufacturing field with steam and water-power plant appliances, heavy electrical equipment and electrical apparatus. Negotiations with several American firms are being actively carried on, according to an announcement made by Laurence Wilder, the American representative of the Brown-Boveri interests, to absorb several firms which are already manufacturing in this country. By this means existing organizations will be retained, and under a divisional plan each type of factory will go into production on certain lines of equipment. Development work for all plants will be done and consulting aid will be given by the Brown-Boveri Co.

One plant is already in operation at Sidney, Delaware County, N. Y., and is making ignition equipment for the United States Navy in conformity with an agreed-upon standardization program. This plant will also make rectifier cylinders. Oil breakers and power mercury rectifiers are other lines of activity already existing in the American market. Complete arrangements will be announced later it is reported.

The Brown-Boveri interests were led to adopt this plan, it is said, because there has been a demand for their equipment of increasing magnitude during the last few years, and also by this plan the company is enabled to give engineering service to American customers.

At the present time the Brown-Boveri interests operate twenty-seven affiliated plants located in nearly all countries of the world, and their American plan is said to be in accord with past experiences in developing an organization in other countries than Switzerland. The final results of this move of one of the largest electrical manufacturers in Europe is exciting interest, and much curiosity exists as to the names of the American firms to be absorbed at an expenditure of around $40,000,000.

Susquehanna River Project Let to Stone & Webster

The big hydro-electric plant which is to be built on the Susquehanna River near Conowingo, Md., as announced in *Power*, Jan. 13, page 79, will be constructed by Stone & Webster, according to press reports. The contract was let by the Susquehanna Power Co., which is owned by the Philadelphia Electric Co. Plans are subject to approval by the Federal Power Commission. It is expected that preliminary work will be started soon.

When completed this plant will develop 460,000 hp., representing an expenditure of $52,000,000, and will be the third largest hydro-electric plant in the United States. In size it will be exceeded only by plants at Niagara Falls and Muscle Shoals. The initial generators will be six, of a combined capacity of 280,000 hp. The plans presented to the Power Commission call for a dam 3,680 ft. long and 103 ft. high at the spillway, creating a reservoir extending about ten miles up the river to near Holtwood. The plant will furnish power for points in southeastern Pennsylvania, and will be connected with the Philadelphia Electric Company's steam plant in Philadelphia.

Sir Adam Beck Says Steam Plant Only Solution

Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, sees no immediate prospects of additional distribution of water from Niagara Falls for power purposes.

Commenting briefly on the suggestion of Paul A. Schoellkopf, president of the Niagara Falls Power Co., that no further power would be available to western New York State until a larger diversion was permitted, Sir Adam is reported as saying that regardless of the detrimental effect which further diversion might have on the scenic value of the falls at Niagara, he believes that negotiations for a new treaty that would mean further distribution of power would require perhaps five years. The suggestion had been put forward several times by the commission, he said, and had been rejected by the Ontario government on the grounds that the delay would make the plan worthless.

The power shortage demands speedier action and Sir Adam asserted, according to press reports, that the construction of a large steam unit is the only scheme that can be carried through in time to meet the deficiency that is sure to prevail in 1926.

Stokers Sold During 1923 and 1924

The Department of Commerce announces the following statistics on mechanical stokers according to reports received from 13 establishments. These data are shown by months for 1924 and 1923 in the following table:

STOKERS SOLD, HORSEPOWER, AND KINDS OF INSTALLATION

Year and Month	Establishments Reporting, Number	Stokers Sold, Number	Installed Under: Fire-tube Boilers Number	Fire-tube Boilers Sq.ft. Heating Surface	Water-tube Boilers Number	Water-tube Boilers Sq.ft. Heating Surface
1924						
January	15	91	7	10,440	84	654,480
February	15	110	11	15,250	99	605,880
March	15	89	12	16,250	77	329,720
April	15	89	15	19,700	74	459,690
May	15	64	3	5,500	61	338,970
June	15	102	19	27,240	83	328,250
July	15	115	14	16,600	101	360,990
August	13	94	17	24,860	77	394,450
September	13	73	27	66,460	46	193,420
October	13	104	7	17,020	97	568,630
November	13	106	11	16,750	95	354,920
December	13	91	18	17,880	73	299,440
Total, 1924	..	1,128	161	253,950	967	4,888,840
1923						
January	15	145	29	34,000	116	798,700
February	15	129	9	11,720	120	654,470
March	15	120	9	12,590	111	676,960
April	15	167	14	20,000	153	833,390
May	15	194	14	19,150	180	985,980
June	15	135	6	8,040	129	589,150
July	15	129	21	34,540	108	490,540
August	15	135	18	26,240	117	690,690
September	15	99	16	27,540	83	577,320
October	15	88	14	23,300	74	302,460
November	15	50	10	13,000	40	149,410
December	15	73	17	28,200	56	296,970
Total, 1923	..	1,464	177	258,320	1,287	7,046,140

Bureau of Mines Needs Engineers

The United States Civil Service Commission, Washington, D. C., announces open competitive examinations to fill vacancies in the Bureau of Mines, for: Petroleum engineer, salary $3,800; natural-gas engineer, $3,800; assistant engineer petroleum, $2,400; assistant natural-gas engineer, $2,400. Application for examination must be received before Feb. 24.

Canal Commission Buys Large Diesel Engines

The Panama Canal Commission has awarded contracts for the construction of a Diesel plant at Miraflores in the Canal Zone, consisting of three Nordberg Diesel engines of 3,750 brake horsepower each. The engines will be of the two-stroke-cycle, single-acting type with six cylinders, 29-in. bore and 44-in. stroke, running at 125 r.p.m. Each engine will be direct connected to a 3,125-kva. three-phase, 25-cycle, 2,200-volt generator of the flywheel type. This is the first instance where generators of the flywheel type have been used in this country, although this is more or less of a common practice in Europe, where large Diesel engines are used. The total weight of each engine including generator is 815,000 lb.

This plant at Miraflores is to be used as a stand-by for the hydraulic electric plant which now furnishes power for the canal. The engines are to operate in parallel with this hydro-electric station, which is about 36 miles distant.

Straight-Tube Benson Plant Nears Completion

Most of the readers of *Power* will remember something of the Benson superpressure boiler which was described in the May 22 and 29, 1923, issues. This steam generator, it will be recalled, was designed to produce steam at the critical pressure, without boiling, by forcing the feed water under a pressure exceeding the critical (3,200 lb. per sq.in.) through a long coil placed in the path of the furnace gases. A short test of this generator, which was erected at the Rugby (England) Works of the English Electric Co., was reported in the March 18, 1924 issue.

Doctor Benson, who is in New York at the time of this writing, expects that the first Benson Plant intended for continuous operation will be completed early in 1925 at the power station of Messrs. Siemens - Schuckert Werke G.m.b.H., at Siemenstadt, near Berlin. "This new plant," said Doctor Benson, "will comprise the first straight-tube Benson generator and superheater, and two turbines of 1,000-kw. capacity each. As at Rugby, steam will be generated at the critical temperature and pressure, then superheated and throttled down to 100 atmospheres for the high-pressure turbine, which will exhaust into the low-pressure turbine at 12 atmospheres."

According to Doctor Benson this new plant will embody the following improvements over that at Rugby: "A better and cheaper generator; a high-pressure turbine with a guaranteed minimum efficiency of 70 per cent, operating at 3,600 r.p.m., thus doing away with reduction gear for small and medium-sized turbo-generator sets; improved valves; governing gears suitable for widely fluctuating load conditions. In addition, the plant is arranged in a manner which will demonstrate the advantages to be obtained when this system of steam generation is used for the extension of existing low-pressure stations."

Doctor Benson stated that the Internationale Benson Patent Verwertungs Aktien Gesellschaft is owned in equal parts by Messrs. Siemens-Schuckert Werke and the Benson Super Power Corporation and is under the management of Messrs. Siemens-Schuckert.

Oil Conservation Board Meeting Opposition

As the President's Oil Conservation Board is getting its program under way, it is becoming apparent that it will have to face a storm of opposition. While the plan to take united action in the prevention of waste had its inception in the industry, the most determined objection comes from the self-same quarter. Some of the oil men are determined to give the commission "a swift kick into the background."

The responsible oil operators have made statements to members of the Board's staff that there is no overproduction of oil and no waste in its recovery. The attitude of a part of the industry, it is feared, is calculated to increase the lack of faith the public has in those engaged in this business.

The President's thought is that this board can develop facts to which the public is entitled and which will tend to clarify the situation. It is believed enough information can be brought together within the next few months to determine whether or not there should be combination in restraint of waste. Returns to the Bureau of Internal Revenue indicate that the oil industry is in a very bad state of health. The hope is that this agency can develop the facts necessary to an intelligent diagnosis of the trouble.

On Jan. 19 Secretary Work, chairman of the President's Oil Board, asked a group of oil men, through letters of inquiry, questions regarding foreign connections affecting production and development of oil. There are several angles to the question of petroleum production waste, and this is the second phase of the investigation, asking for co-operation, and stating that the determination of an adequate national oil policy will be furthered by a frank statement of facts and opinions.

Production and development in this country are definitely influenced by conditions of demand and supply abroad, it is pointed out, and the co-operative study undertaken by the board and leaders of the American industry is expected to furnish valuable information on existing conditions. Among other things on which the board asks the opinion of leaders in the industry are the possibility of a world oil shortage, the outlook for the future of refining, the present surplus of foreign supply over requirements and the advisability of restricting oil exports from the United States.

Ideals for Engineers

"IF OUR engineers would be a little more vocal, if they would act more in the collective sense, and if instead of confining our activities to a partly developed engineering council for the nation, we should develop engineering councils for each municipality and for each state which would stand on guard on all public questions—I say all questions, for there are practically none today that has not engineering implications — we could transform the thought of this nation within another twenty years."

The foregoing statement was made by Commerce Secretary Hoover at the banquet of the regional meeting of the American Institute of Electrical Engineers, in Washington, January 23.

French Tidal Power Station Described

The French decree of Aug. 22, 1924, authorizing the construction of a tidal power station in the estuary of the Aber Vrac'h (Finistre) is described by G. Trautner in *La Technique Moderne*, Nov. 15, 1924. The article says that in this particular case quite a short sea barrage, about 490 ft., will suffice. The turbines there installed will be operated in conjunction with others at a fresh-water barrage upstream. The function of the upstream dam is to assist in regulating the flow of water and the power developed.

The two dams are about 3½ miles apart, and according to the height of the tides, from 53 to 170 million cu.ft. of water will be impounded between them. In the sea barrage there are to be four vertical-shaft reaction turbines geared to two alternators with variable poles. The flow through each turbine will vary about 500 to 1,000 cu.ft. per second, under a head variable from 2.6 to 17.4 ft. The maximum power developed will be about 1,650 hp. per turbine. At the fresh-water barrage the head will vary from 26 to 115 ft. and about 425 million cu.ft. of water will be impounded.

The equipment will here consist of two units, each with a turbine, asynchronous alternator and pump. During periods when there is an excess of tidal power available, the surplus will be used to pump water to an immediate storage reservoir at the upper dam, whence it can be drawn as later required. The object of the intermediate reservoir is to prevent the upper reaches of the river being made saline. It is estimated that about 7,000,000 kw.-hr. per annum will be derived from the tidal power station and about 4,000,000 kw.-hr. from the upstream station. The capital expenditure is expected to be about 35 million francs.

Ottawa River, Canada, Project Nearing Completion

The development of the Ottawa River Power Co. has been kept up to schedule and is now nearly completed, according to government reports. The installation will develop 25,000 hp., and it is said that this has been almost entirely sold. As sale of power warrants additional installations, a second 25,000-hp. unit will be put in, and provision has been made for a third generator. The Ottawa River Power Co. is a subsidiary of the Ottawa Hull Power Co.

Vashon Island Has Floating Power Station

On Dec. 16 the three-mile 6,600-volt submarine cable, which supplies light and power to Vashon Island, Washington, was injured by storm and possibly by dragging anchors. After repeated efforts to locate the trouble, the entire length of cable was taken to Seattle for repair. In the meantime the countryside was scoured to procure auxiliary generating equipment to provide service to the community until such time as the cable could be replaced.

After much effort a 200-hp. McEwan engine, direct connected to an alternator, was found, and the ocean-going tugboat "Roosevelt" was chartered. The engine-driven unit was bolted to the after deck of the "Roosevelt," steam connections made from the boilers of the tug and a tarpaulin roof built over this improvised generating station and the "Roosevelt" tied up at the Old Ferry Dock, Portage, on Vashon Island. The overhead feeder was run down and put in the span from the last pole of the tug's rigging. On Tuesday, Dec. 23, the island had light for its Christmas festivities, according to the *Puget Sound Electric Journal.*

Great Britain's Petroleum Trade

The magnitude of Great Britain's petroleum trade and its dependence upon foreign sources of supply are set forth at length in *Commerce Reports*, Jan. 5 issue. Some of the points of interest to *Power* readers are:

The crude-oil imports during the first 10 months of 1924 were over 438,000,000 gal., 104,000,000 gal. more than in the corresponding period of 1923—a gain of over 30 per cent. Compared with the first 10 months of 1922, the gain was 105 per cent.

For the first 10 months of 1924 fuel oil imports totaled nearly 400,000,000 gal., a gain of 24,000,000 gal., or 8 per cent over October, 1923, but 8,700,000 gal. less than in October, 1922, when the Anglo-Persian refineries in Great Britain were not operating at anything like their present capacity.

Lubricating oil is now produced on a large scale in this country, but the imports still continue to be very large. During the first 10 months of the year lubricating oil imports totaled over 96,000,000 gal.—an increase of nearly 10 per cent over the corresponding period of 1923 and of nearly 40 per cent over the first 10 months of 1922.

No Diversion Legislation by Present Congress Expected

No legislation in the matter of diversion from Lake Michigan at Chicago is expected at this session of Congress. Since the Supreme Court's decision the subject has come in for intensive study on each side of the Capitol. It is becoming increasingly apparent that all the facts necessary to intelligent legislation are not available. For that reason it is anticipated that the War Department will issue a temporary permit continuing the status quo at Chicago. Congress probably will provide for the gathering of the necessary data.

The logical next step, it is pointed out, is to initiate negotiations looking to the revision of the treaty of 1909. It is recognized that the entire question of diversion must be settled on a new basis. The treaty of 1909 does not preclude the diversion of 10,000 cu.ft.-sec. at Chicago. It does, however, put Canada in a position where she has a right to demand equities and now that Chicago is in a different frame of mind the difficulties will not be so great, it is believed, in determining what Chicago will do to offset the damages caused by its use of water from the lake system.

In the matter of power alone no one questions that the 10,000 cu.ft.-sec. diversion to the Mississippi Valley if allowed to go to the sea by the way of the St. Lawrence constitutes potential power to the extent of 300,000 hp. to Canada and 200,000 hp. on the American side.

A resolution of protest against the right of Congress to pass Chicago's lake-water diversion legislation, now before a special Senate Committee at Washington, was unanimously adopted at a session of the two-day conference of delegates from eighty Great Lakes cities held under the auspices of the Great Lakes Harbor Association. Besides the arguments advanced against the Chicago diversion, the resolution says: "If the several cities on the Great Lakes were to divert the lake waters in the degree that is now being done by the City of Chicago, the integrity of the Great Lakes as a navigation highway would be sadly impaired."

Arguments against the diversion are also being presented before the Senate Committee conducting hearings on the proposed St. Lawrence-to-the-Gulf waterway. Attorney Daugherty, of Michigan, who represented seven lake states against the Chicago action, contended that under the present situation the State of Illinois was in the position of claiming the entire contents of Lake Michigan, although possessing riparian rights to less than one-fifteenth of its surface.

Prof. M. I. Pupin Nominated to Head A. I. E. E.

PROF. MICHAEL I. PUPIN, head of the electrochemical department of Columbia University, New York City, has been nominated for president of the A. I. E. E., it is reported. News of his nomination was followed by the withdrawal of the three other candidates, Charles E. Skinner, R. F. Schuchardt and Lewis T. Robinson. This is the second society to honor Professor Pupin, as the American Association for the Advancement of Science recently selected him for its president. Professor Pupin is such an outstanding figure in the scientific, literary and engineering world, and his personality is so delightful that his selection for this new honor is not surprising.

Batiscan River Power Plant Planned

A new power plant is to be erected on the Batiscan River, Canada, by the Shawinigan Water & Power Co., according to a recent announcement in *Commerce Reports*. This development is to have an installed capacity of 20,000 hp., with the possibility of being increased later to 30,000 hp. The project is to cost approximately $1,500,000 and is expected to be completed about May, 1926. One of the features of this undertaking is the driving of a tunnel, nearly three-quarters of a mile long, having a diameter of 13 ft. inside the reinforced concrete lining. It will be driven under the present plant, which will continue in operation. The dam will back up the water to Chute Platte, a distance of two miles.

Conference on Muscle Shoals Under Way

By a vote of more than four to one the Underwood Muscle Shoals bill was sent by the House on Jan. 27, to a conference with the Senate instead of to the Military Affairs Committee, where it was considered likely that the consideration of the bill would be delayed.

Just after the deciding vote of 181 to 41 was taken, the House named as its conferees, Representatives McKenzie and Morin, the ranking Republican members of the Military Affairs Committee, and Representative Quin, the ranking Democrat.

Representative McKenzie assured the House that he would do all he could to maintain the fundamental demands expressed by the House when the Ford bill was passed last spring, including the reservation for war-time use and the compulsory manufacture of nitrates for fertilizer.

The Senate selected on Jan. 28, Senators Keyes, New Hampshire, and McKinley, Illinois, Republicans, and Kendrick, Wyoming, Democrat, as its conferees after Chairman Norris, of the Agricultural Committee, with Senators McNary, of Oregon, and Smith, of South Carolina, the ranking Republican and Democratic members, had declined to serve.

As this is written both opponents and supporters of the Underwood measure are expressing the opinion that this action indicated that the bill, with some amendments, would pass both the House and Senate at the current session.

Delaware River Treaty Ready for Ratification

As tentatively announced in *Power*, Dec. 23, 1924, page 1040, the Delaware River Treaty has been signed by the Commissioners of New York, New Jersey and Pennsylvania and it now remains for the several states to ratify it for it to become operative.

The ultimate expenditure involved, is reported as being in the neighborhood of $500,000,000. The operation of the treaty is expected to eliminate water shortages in New Jersey, allow dams and other improvements to be built which will permit regulation of the river's flow, doing away with floods, and allow for power production.

The right to build dams in the Delaware River is reported as being of importance in Pennsylvania for the developing of hydro-electric power for that state. Previously, the building of dams had been prohibited by a treaty made about a century ago. The power potentialities of the river, which are estimated at 500,000 hp., have hitherto been wasted.

Italian Electrical Imports Show Recovery

Imports into Italy of generators and motors, transformers and electrical apparatus increased slightly during the first six months of the year 1924 as compared with the corresponding period of 1923. While in both quantity and value the total for 1922 was not reached, the expanding domestic electrical manufacturing industry is constantly developing its home market, as well as reaching out overseas. The value of generators and motors exported from Italy during the first six months of 1922, 1923 and 1924 exceeded the value of these articles imported during the same periods.

The imports by countries of origin, which are given for these three classes of electrical equipment only, are set forth in the following tables:

ITALY'S IMPORTS OF ELECTRICAL EQUIPMENT

Articles and Countries of Origin	Jan.-June, 1922 Quintals	Jan.-June, 1923 Quintals	Jan.-June, 1924 Quintals
Generators and Motors:			
Austria	763	380	412
Czechoslovakia	19	24	1,180
France	146	158	869
Germany	6,289	4,921	3,624
Great Britain	494	732	141
Sweden	23	10	19
Switzerland	392	154	683
Hungary	713	1,319	1,296
United States	3,315	107	1,772
Other countries	55	22	93
Total	12,209	7,827	10,089
Transformers:			
Austria	622	120	127
Germany	3,910	2,057	2,233
Hungary	182	352	186
United States	780	583	603
Other countries	142	190	51
Total	5,636	3,302	3,200
Miscellaneous Apparatus:			
Austria	541	123	119
Belgium	62	123	7
France	94	180	346
Germany	5,484	3,454	2,782
Great Britain	123	69	208
Switzerland	169	207	319
Hungary	26	55	40
United States	139	176	395
Other countries	37	32	112
Total	6,675	4,419	4,328

Baker River Development To Be Finished This Year

The most important work undertaken by the Puget Sound Power & Light Co. within the last few years is the Baker River hydro-electric development, now under construction and scheduled for completion by the end of 1925.

The present development provides for a 250-ft. concrete diversion dam, concrete-lined tunnel, and power house containing two horizontal double overhung reaction-type Allis-Chalmers 20,000-hp. turbines operating under a head of 228 ft., direct connected to two General Electric 19,500-kva. generators.

The demand now exceeds the hydro-electric capacity of the system by such an amount that it is no longer economical to carry the excess with steam power and the development of a major water power is warranted.

For the last 12 miles of its length the river flows through a nearly level valley which in past geologic times probably joined the valley of the Skagit, but is now shut off from it by a dike of hard homogeneous limestone 1,000 ft. high and 2,000 ft. thick, which by some convulsion of nature has been thrown directly across the river's course. Through this barrier the river has cut a narrow gorge and again finds its way unobstructed to the Skagit. About midway of this gorge, at its narrowest part, a massive concrete dam 250 ft. high is being constructed between the almost vertical rock walls to create the head and the large storage lake for the Baker River power plant.

Sixteen hundred feet below the dam will be the power house, where at present two generating units of 20,000 hp. each will be installed; ultimately, two more will be added to make the total capacity 80,000 hp. Water will be led from behind the dam through a 22-ft. concrete-lined tunnel in solid rock to a point just back of the power house, thence through short steel penstocks to the turbines and into the river again.

Two Power Trust Investigations Now Under Way

IN ITS consideration of the Norris resolution proposing an exhaustive probe of the entire business of power companies the Interstate Commerce Committee of the Senate has discovered that both the Department of Justice and the Federal Trade Commission for some time have been conducting investigations to satisfy themselves that there is no violation of law in the interrelation and conduct of power companies. As this is written, the committee has not decided whether or not to launch a Congressional investigation in addition, but it is known that any such proposal will meet with strong opposition, both in the committee and on the floor of the Senate, on the ground that it would be a duplication of a federal activity and would be calculated to inject politics into a matter that should be handled in a strictly legal way.

Great Falls Legislation May Pass This Congress

While the action of the District of Columbia Committee of the House of Representatives in reporting favorably on the Great Falls hydro-electric project places that legislation in a position where it may become a law at this session of Congress, it is believed that the opposition of majority leaders to a measure calling for the ultimate expenditure of $44,421,000 will prevent its passage in the House.

The committee, in reporting favorably on the bill, urges the immediate construction of the first unit of the project, which is the construction of a dam at Chain Bridge, a few miles above Washington, at a cost of $13,600,000. It is estimated that this dam alone would make possible the production of 415,000,000 kw.-hr. annually. The committee accepts an estimate that power could be produced at the Chain Bridge dam for two mills less than it is being produced for at the existing steam plant in Washington.

As amended in the House, the bill requires that the Federal Power Commission obtain guarantees for the disposal of the power before the work is begun. It is estimated that the Washington area will require 500,000,000 kw.-hr. of electricity in 1930 and 900,000,000 kw.-hr. in 1945.

Societies To Hold Meetings On Oil and Gas Power

At a recent conference of co-operating organizations, the date for the first "Oil and Gas Power Week" was set for April 20-25, 1925. The week will be celebrated by technical meetings to be held in selected cities throughout the country—at least 25 in number. Industrial plants in the selected communities will be asked to co-operate. Topics to be studied during the week will be the use of the Diesel engines in central stations, industrial plants and on shipboard, methods of testing oil and gas engines, and problems in design, weight reduction, operating costs, etc.

Co-operating with the American Society of Mechanical Engineers in plans for the week are the following organizations: National Association of Stationary Engineers, American Society of Marine Engineers, American Chemical Society, American Society of Naval Engineers, National Safety Council, American Society of Agricultural Engineers, United States Chamber of Commerce, Society of Naval Architects and Marine Engineers, United States Bureau of Mines, and the United States Department of Commerce.

A general committee and an executive committee will be appointed by these organizations to make and execute plans for the week. W. E. Bullock, assistant secretary of the A. S. M. E., has been appointed to act as corresponding secretary, and inquiries addressed to him at 29 West 39th St., New York City, will be answered.

Power from Mulshi Petha Dam for Bombay

The Tata Hydro-electric Power Supply Co. has a dam under construction at the junction of the Nila and Mula Rivers, about 78 miles from Bombay. It is known as the Mulshi Petha Dam and is designed to afford net storage of 13,000,000,000 cu.ft. of water for power purposes, and permitting of 345,000,000 kw.-hr. available at Bombay, according to the press. The dam, when completed, will be 170 ft. high and approximately 3,500 ft. in length. It is expected that the full development will be 150,000 hp., which will replace 325,000 tons of coal yearly.

Second Long Beach Turbine Put in Operation

The second 35,000-kw. turbine generator for the Long Beach station of the Southern California Edison Co. was started on Jan. 21, a year after the order for the 70,000-kw. equipment was placed. This second unit left the General Electric Company's plants in Schenectady, N. Y., on Nov. 26, reached Long Beach on Dec. 8 at midnight, and work was started placing it on the bases by nine o'clock on Dec. 9. The boilers which supply steam to the turbines are designed for operation with either natural gas or oil as fuel. The construction of the plant was rushed to meet the growing demands for power caused by the rapid industrial development of the Los Angeles harbor district. The first unit has been generating 400 kw.-hr. per bbl. of fuel oil.

Exports of Power Machinery To Brazil Increase

Brazil's purchases of power-generating machinery (omitting electric) declined very materially in 1923 compared with 1922, but show a recovery in the first nine months of 1924 according to United States customs' figures.

Mechanical-drive turbines, boilers, and steam-engine accessories and parts were purchased in greater quantities during the first nine months of 1924 than in the corresponding period of 1923. The following table gives exports of power-generating machinery (omitting electric) for the first nine months of 1923 and 1924:

UNITED STATES EXPORTS OF POWER-GENERATING MACHINERY TO BRAZIL

Classes	January-September, 1923	January-September, 1924
Steam engines:		
Stationary, except marine	$775	$16,693
Marine, except turbines	619	.....
Mechanical-drive turbines	3,670	68,900
Engine accessories and parts	150,373	202,930
Boilers	47,064	57,923
Condensers, heaters, and accessories	770	5,723
Injectors, gages, and other boiler accessories and parts	7,390	16,439
Internal-combustion engines, stationary and portable:		
Diesel and semi-Diesel	.....	3,342
Other stationary over 10 horsepower	3,956	7,559
Other marine, except detachable	2,772	1,484
Accessories and parts	5,362	19,201
Waterwheels and water turbines:		
Under 500 horsepower	300	3,275
Over 500 horsepower	.....	800
Total	223,051	404,269

New Hydro Plant Announced for Deferiet

The construction of a 15,000-hp. hydro-electric plant at Deferiet, Jefferson County, N. Y., at a cost of $1,000,000, to be started early in the spring, was announced by John N. Carlisle at Watertown on Jan. 17. The new power plant, which is to be completed before the end of 1926, will contain three 5,000-hp. vertical-type hydraulic turbines to be connected with three 5,000-kva. generators.

Most of the power generated will be used in the Deferiet mill of the St. Regis Paper Co., and the surplusage will be tied in with the Northern New York Utilities, Inc., system, it was announced.

Hydro Progress in Canada During 1924

A review by the Dominion Water Power and Reclamation Service of the Department of the Interior, Canada, partly given here, indicates that in hydro-electric and water power development the year 1924 was one of pronounced activity throughout the Dominion. Not only was a substantial increase recorded in the total installation, but many large projects were advanced to such a state that a further extensive increase will be effected during the year 1925. More than 300,000 hp. was added during the year, bringing the total installation in the Dominion to a figure of 3,569,275 hp., while with the installations nearing completion this figure will be increased by more than 600,000 hp. during 1925.

Special interest attaches to the activities of the present time when compared with those of a few years ago, in the magnitude of individual developments and the speed achieved in their construction. Where a few years ago blocks of ten to twenty thousand horsepower were thrown upon the market, now plants in excess of one hundred thousand horsepower are brought into operation in a single year. Modern construction methods have also advanced to meet the demand for speedy development so that it is not uncommon for plants of large magnitude to be completed within the space of twelve months.

Ontario

A substantial increase amounting to some 132,000 hp. was made during the year to the total water power installation in the Province of Ontario. While the greater part of this was accounted for in the addition of units to existing stations, there were also several entirely new developments. These activities embraced all parts of the Province, the most important being in the territory served by the Hydro-Electric Power Commission, in the mining territory of northern Ontario and in the extreme western part at Kenora.

The Ontario Hydro-Electric Power Commission carried on a vigorous program of construction throughout the territory that it serves. At the head of the lakes the capacity of the Nipigon station was increased by the addition of two 12,500-hp. units, bringing the total to 50,000 hp. Two further units of similar capacity, which are being added in 1925, will complete the designed capacity of the Nipigon station. In connection with the Nipigon development it is of interest to mention a field investigation made by the Commission during 1924 with respect to diverting waters from the upper Albany River flowing into Hudson Bay, to Lake Nipigon.

On the Niagara River at the Queenston station the Commission brought into operation two more 55,000-hp. units, Nos. 6 and 7. The eighth and ninth units of similar capacity will, it is expected, be installed during 1925 and the final designed capacity of ten units totaling 550,000 hp., be achieved in 1926.

In the mining district of northern Ontario a particularly active program of construction was carried out and new installations brought into operation which should overcome the power shortage that has existed for the last few years. For the Porcupine gold field two developments were completed and brought into operation during the year, Northern Canada Power Co. on the Quinze River in Quebec, and the second by the Hollinger Consolidated Gold Mines, Ltd., at Island Falls, on the Abitibi River, where 24,000 hp. was installed. For the silver-mining area the Northern Ontario Power Co. completed the alterations to the Matabitchuan plant, increasing the capacity to 13,200 hp.

Quebec

Of the developments completed and brought into operation during the year, the largest was that of the St. Maurice Power Co., at La Gabelle, on the St. Maurice River, with an installation of 120,000 hp. This plant, embodying the most up-to-date features of hydro-electric design, was constructed in record time well in advance of the preliminary program. All the output has been contracted for by the Shawinigan Water & Power Co.

The Montreal Light, Heat & Power Consolidated added two units of 11,300 hp. each to its Cedars Rapids plant on the St. Lawrence River, thus completing the designed capacity of this plant of 18 units totaling 200,000 hp.

Among the numerous plants under construction and nearing completion, the most outstanding is that of the Duke-Price Power Co. at the Grand Descharge on the Saguenay River. It is expected that the initial installation of eight units, totaling 360,000 hp., will be in place ready for operation during 1925. A large part of this power has been already contracted for by Price Brothers & Co. for use in the company's extensive pulp and paper mills.

A review of the water-power activities in Quebec is not complete without a reference to the very important work being carried on by the Quebec Streams Commission in the creation of storage reservoirs. The commission has already in operation reservoirs of large magnitude on the St. Maurice and St. Francois Rivers and of lesser size on the St. Anne de Beaupre River. During 1924 the Lake Kenogami reservoir was carried well toward completion. This will regulate the flow of the Chicoutimi and Sable Rivers and, when completed

in 1925, will have a total capacity of 13 billion cubic feet. The commission also expects to have the Metis reservoir finished before the spring of 1925. It will have a capacity of over 2¾ billion cubic feet and will regulate the flow of the Metis River.

New Motor Fuel Announced by Arthur D. Little, Inc.

The Barnsdall Corp., in conjunction with Arthur D. Little, Inc., has organized the Petroleum Chemical Corp. to manufacture and distribute a new motor fuel. According to statements of the Barnsdall company: "For the last three years chemists and engineers of Arthur D. Little, Inc., at the laboratory at Cambridge, Mass., have been concentrating with a large scientific and technical organization upon the fundamental chemistry of petroleum hydrocarbons, with the object of establishing new values in petroleum. These intensive studies have culminated in the development of a group of interrelated processes based on a new vapor phase cracking process, which according to the range of products desired, yields from cracking stock from 40 to 55 per cent of motor spirit.

Water-Power Projects

Black River Project—A dam 129 ft. high across Black River near Piedmont, Mo., is proposed in an application by Willis H. Meredith to the Federal Power Commission for a preliminary permit. The power is intended for general sale.

Deep Creek, Mojave River Project—A license to develop power on Deep Creek, a tributary of the Mojave River in San Bernardino County, near Hesperia, is sought by the Appleton Land, Water & Power Co. It is proposed to create a reservoir of 1,000 acre-feet capacity. A conduit will carry the water to the power house near the intake of the Hesperia ditch. Some 2,000 hp. will thus be made available.

Clearwater River Project—The city of Lewiston, Idaho, has applied for a preliminary permit covering a project on Clearwater River, near Spalding. It is proposed to construct a dam 30 ft. in height and the appurtenant power structures. This will make possible the development of 2,500 hp. The power is to be used for public-utility purposes.

Kern River—William C. McCowan has applied to the Federal Power Commission for a preliminary permit covering a project on Kern River in California. He proposes to store flood waters in the Isabella reservoir and to drop the water through existing power houses on Kern River to the irrigated lands south of Bakersfield. The application conflicts with that of the Kern River Water Storage District.

Mokelumne River Project—The East Bay Municipal Utility District, of which George C. Pardee, of Oakland, Calif., is president, has filed an application with the Federal Power Commission for a preliminary permit covering a development on Mokelumne River in Amador and Callaveras Counties, Calif. It is proposed to erect a dam 320 ft. high below the mouth of Salt Gulch. This will create a reservoir with a capacity of 187,000 acre-feet. It will be operated in connection with a 220,000 acre-foot reservoir to be formed by an 85-foot dam on Dry Creek, seven miles below Ione, which is not included in this application. The principal purpose of the reservoir is to provide a water supply for the East Bay cities, but there will be incidental development of power. A power house will be erected at the dam with equipment capable of generating 18,000 horsepower.

Obituary

Nathaniel Shepard Keith, first secretary of the A. I. E. E. and electrical inventor and metallurgist, died in Philadelphia on Jan. 27, at the age of eighty-seven. He was born in Boston in 1838 and spent the early years of his career as a mining and metallurgical engineer in Colorado. He has patented many inventions of note in the electrical field. In 1883 he was one of the editors of *Electrical World* and was at that time instrumental in starting the American Institute of Electrical Engineers, which he served as secretary in 1884-85, and of which he has since been one of its distinguished members. Besides the A. I. E. E., Mr. Keith belonged to the A. I. M. & M. E., American Electrochemical Society and the Engineers Club of Philadelphia. He has to his credit several books and magazine articles.

Roger Morse Freeman, New York City, a consulting and construction engineer of great ability and unusual promise and son of the prominent engineer, John R. Freeman, died in Providence, R. I., on Jan. 22 of heart failure following an attack of appendicitis. He was in his thirty-third year.

Mr. Freeman was born in Winchester, Mass., in 1892 and gained his early education in Providence, where his family moved when he was three years old. Later, he entered the Massachusetts Institute of Technology, the Alma Mater of his great father, graduating from there in 1913 in electrical engineering. For two years he served as assistant engineer with his father on the design of large hydro-electric developments in this country and Canada. Later, he constructed many important plants and industrial buildings. One of the recent projects with which he was connected in a consulting capacity was the hydro-electric development on the Tippecanoe River in Indiana. He was a member of the A. S. M. E., the A. I. E. E., A. S. C. E. and other societies.

Society Affairs

The Cincinnati Section of the A.I.E.E. will hold a meeting on Feb. 12 at which William A. Del Mar will present a paper on "The Failure of Dielectrics."

The Vancouver, Wash., Section of the A. I. E. E. will have "The Alouette Power Development" as the topic for its Feb. 6 meeting. E. E. Carpenter will be the speaker.

The Hartford Section of the A.S.M.E. will hold a meeting on Feb. 11 at the Engineer's Club. "Combustion" is to be the subject.

The Utah Section of the A.S.M.E. will hold a joint meeting with the University of Utah Student Branch on Feb. 13. "Power Generation" will be the subject.

The Colorado Chapter No. 1 of the National Association of Practical Refrigerating Engineers has been organized. George Peck was elected president and E. H. Coffman, secretary.

The Inland Empire Section of the A.S.M.E. will hold a joint meeting with the Spokane Section of the A.I.E.E. on Feb. 27. "Testing Waterwheels by Use of the Gibson Apparatus and Method," illustrated, by R. L. Hern, will be the attraction.

The Toledo Section of the A.S.M.E. will have as the subject for its Feb. 19 meeting, which will be held at the Toledo Chamber of Commerce, "Automatic Stokers of Various Types," illustrated with the stereopticon. L. R. Stowe, of the Stowe Stoker Co., will be the speaker.

Business Notes

The Scott Valve Manufacturing Co., Detroit, Mich., announces that O. L. Chapman has joined the sales force of the company.

The Elliott Company, Jeannette, Pa., states that A. L. Rider has been appointed district manager of the New England territory with offices at 830 Massachusetts Trust Bldg., Boston, Mass.

The Pittsburgh Valve Foundry & Construction Co., Pittsburgh, Pa., announces the appointment of the R. J. Crozier Co., Fuller Bldg., Philadelphia, Pa., as its sales representative for the Philadelphia district.

The Roller-Smith Co., 233 Broadway, New York City, announces the appointment of W. H. Pugh, formerly superintendent of works, as its representative in the northeastern part of Pennsylvania, with headquarters at the factory in Bethlehem, Pa.

The Bayer Co., 4067 Park Ave., St. Louis, Mo., manufacturer of soot blowers, valves and foundry products, announces that John P. Hillman, recently connected with the engineering department of Hester-Bradley, St. Louis, Mo., has become manager of its valve department.

The Sangamo Electric Co., Springfield, Ill., has opened up a direct sales office in Boston, Mass., at 19 Pearl St. It will be in charge of Stafford J. King, who has been sales manager for the company in the New England territory for the last twelve years. W. H. Carpenter and R. D. Savage will assist Mr. King.

The Pure Carbon Co., Wellsville, N. Y., announces that H. H. Miller, 7719 Lyman St., Pittsburgh, Pa., is its Pittsburgh representative. Announcement is also made that the company will have additional representatives as follows: The Simpson Power Equipment Co., 7016 Euclid Ave., Cleveland, and the Pure Carbon Co., General Motors Bldg., Detroit, Mich.

The McMyler-Interstate Co., Cleveland, Ohio, manufacturer of coal-handling equipment, announces the removal of its Detroit office from 1701 Washington Boulevard Bldg. to 1156 Book Bldg. The change becomes effective Feb. 1.

Foote Bros. Gear & Machine Co., Chicago, Ill., announces that Chas. Bond & Co., Philadelphia, Pa., is its agent for the distribution of its products in eastern Pennsylvania and Maryland, Delaware and all of New Jersey south of Mercer County. The Thrall Electric Co., Havana, Cuba, is the company's representative in Cuba. The F. Somers Peterson Co. of San Francisco will distribute the company's product in northern California and the Thomas Machinery Co. of Los Angeles serves the southern section.

The Morgan Engineering Co., Alliance, Ohio, designers, manufacturers and contractors for traveling cranes, etc., announces the appointment of the following district representatives: C. O. Cromwell, 2230 First National Bank Bldg., Detroit; F. E. Bausch, 1105 Chemical Bldg. St. Louis; Duncan A. MacLeod, 918 Ellicott Sq., Buffalo, N. Y.; R. R. Glover, 2310 Union Central Bldg., Cincinnati, Ohio; W. R. McDonough & Co., First National Bank Bldg., Cleveland, Ohio; McMullen Machinery Co., 64 Ionia Ave., Grand Rapids, Mich.; Millholland Sales & Engineering Co., 225 Indiana Terminal Warehouse Bldg., Indianapolis, Ind.; C. B. Davis Engineering Co., Brown-Marx Bldg., Birmingham, Ala.; P. I. Perkins Co., 110 High St., Boston, Mass.; Stewart H. Ford, Mutual Bldg., Richmond, Va.; Dravo-Doyle Co., Schaff Bldg., Philadelphia, Pa.

Trade Catalogs

Fire Brick — Laclede-Christy, St. Louis, Mo. Bulletin describing the firebrick manufactured by this company.

Oil Engines—De La Vergne Machine Co., 940 East 138th St., New York City. Bulletin No. 184, describes De La Vergne Diesel oil engines, horizontal type S-1 without air compressors. Illustrations, cross-sections, drawings and dimensions are included in the catalog.

Heaters—O. E. Frank Heater & Engineering Co., Inc., Buffalo, N. Y. Bulletin No. 25, describing heaters, coolers, condensers, exchangers feed-water heaters, etc., has just been received. Filled with illustrations and data tables, it adequately covers the service rendered by this company.

Oil Circuit Breakers—General Electric Co., Schenectady, N. Y. A new bulletin, No. 47495.1, contains descriptions of types FH-103, FH-203, FH-206 and FH-209 oil circuit breakers. Well illustrated and with tables of characteristics, dimensions and capacities, the bulletin is worth keeping on file.

Feed-Water Heaters — Elliott Co., Pittsburgh, Pa. Bulletin D-1 is a new bulletin on feed-water heaters manufactured by the company. The application of different types of heaters to various conditions, advantages and disadvantages of the various types is discussed with appropriate illustrations showing the construction and installations of the heaters.

Grates—Marion Machine, Foundry & Supply Co., Marion, Ind. Bulletin No. 209, "Marion Master Grates," describes this line of hand-operated grates.

Motors—Century Electric Co., St. Louis, Mo. Leaflet "How Century Polyphase Motors are Built," describes the squirrel-cage induction polyphase motors built by this company.

Heaters, Unit—American Blower Co., Detroit, Mich. Bulletin No. 1218, "American Blower Venturafin Unit Heaters," describes, with photos of installations, this heater adaptable to small or big industrial plant.

Engines—Engberg's Electric & Mechanical Works, St. Joseph, Mich. Catalog No. 302 describes vertical, enclosed, self-oiling engines of 1 to 100 hp. Photos, sectional views and a table of horsepower add to the interest and value of the catalog.

Coming Conventions

American Association of Oil Burner Manufacturers. Leod D. Becker, Bank of Galesburg Bldg., Galesburg, Ill. Convention and exhibit at Edgewater Beach Hotel, Chicago, April 1-3.

American Boiler Manufacturers Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Midwinter meeting at Cleveland on Feb. 12.

American Ceramic Society. R. C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Columbus, Ohio, Feb. 16-21.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at New York City, Feb. 9-13. Convention at St. Louis, April 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 16-19.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 22-26.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago. National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	Jan. 26, 1925
Pool 1	New York	$2.50@$3.00
Smokeless	Boston	1.72
Clearfield	Boston	2.10@ 2.50
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.50@ 1.70
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.35@ 1.75
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	$2.25@$3.15
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.60@ 1.75

FUEL OIL

New York—Jan. 29, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Jan. 26, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.651c. per gal.; 38@40 deg., 6.197c. per gal.

Pittsburgh—Jan. 20, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.

Dallas—Jan. 26, f.o.b. local refinery, 26@30 deg., $1.80 per bbl.

Philadelphia — Jan. 23, 28@30 deg., $2.31@$2.393 per bbl.; 18@22 deg., $2.10@$2.162; 13@16 deg., $1.89@$1.953 per bbl.

Boston—Jan. 26, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5.37½c. per gal.

Cincinnati—Jan. 20, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 5¾c. per gal.; 30@32 deg., 6¼c. per gal.

New Plant Construction

Calif., Beverly Hills—Globe Ice Cream Co., 230 West Jefferson St., Los Angeles, will build a 1 story, ice cream plant, on Alpine Dr. Estimated cost $225,000. Work to be done by separate contracts under supervision of J. Hausfelder, company engineer.

Calif., Chico—F. Flowers is having plans prepared for the construction of irrigation works, including one 8 in. centrifugal pump, 4 sec.-ft. capacity, 20 ft. lift, 15 hp. motor. F. S. Robinson, 4814 5th St., is engineer.

Calif., Los Angeles—W. Bruce, Chapman Bldg., Archt., is making preliminary plans, for the construction of a 12 story apartment house, on Alta Vista Blvd. Estimated cost $1,500,000. Owners name withheld.

Calif., Los Angeles—The Los Angeles Investment Co., will build a 12 story, store and office building, including 5 elevators and steam heating plant, on Broadway near 10th St. Estimated cost $600,000. Work to be done by separate contracts under the supervision of Walker & Eisen, 701 Great Republic Life Building, Archts.

Calif., Los Angeles—The Sun Realty and Finance Co., 1414 Los Angeles St., awarded contract for the construction of an 11 story loft building, including steam heating system, on 7th St., to Scofield Engineering and Construction Co., Pacific Finance Bldg., $1,904,000. Contract does not include elevators.

Calif., Oakland — Providence Hospital, c/o R. A. Herold, Forum Bldg., Sacramento, Archt., having plans prepared for the construction of a 5 story hospital building, at Webster and Summit. Estimated cost $500,000.

Calif., Richvale — A. A. Bradford, Box 862, Chico, is having plans prepared for the construction of irrigation works, including 5 centrifugal pumps, 12 in., 50 sec.-ft., total capacity 4 ft. lifts; one 125 hp. gasoline motor. Estimated cost $15,000. Private plans.

Calif., San Francisco — Bd. of Public Works, M. M. O'Shaughnessy, City Engr., will receive bids until February 4, for the construction of an outfall sewer system, including pumps on Great Highway and Vicente St.

Conn., Rainbow — The Stanley Works, New Britain, awarded contract for the construction of a power plant including dam, at Poquonock, to create an artificial lake, 8,000 kw. power output, to the Power Construction and Engineering Co., Worcester, Mass. Estimated cost $1,000,000.

Fla., Bradenton — Hotel Corporation of Bradenton, J. T. Campbell, Secy. and Treas. having plans prepared for the construction of an 8 story hotel, at Price and Washington Sts. Estimated cost $500,000. F. Winn, Citizens Bank Bldg., Tampa, is architect.

Fla., Coconut Grove—Bay Front Holding, Inc., Miami and Coconut Grove. H. A. Ahlman, Pres., plans the construction of a 10 story hotel on bay front.

Fla., Palm Beach—J. E. R. Carpenter, 598 Madison Ave., New York, Archt., is preparing plans for the construction of a hotel here. Estimated cost $1,000,000. Owner's name withheld.

Ill., Carthage—The City will receive bids in March for the construction of waterworks, including pumping equipment, tank on tower, mains, etc. Caldwell Engineering Co., 502 Ayers Bank Bldg., Jacksonville, Ill., is engineer.

Ill., Elgin—Sanitary District of Elgin, E. N. Herbster, Pres. Bd. of Trustees, 12 Spurling Block, will receive bids until March 2, for furnishing equipment for two sewage stations, complete with electric motors, switch-boards, starting apparatus, and centrifugal pumps.

Ill., Lebanon—The city is having plans prepared for water works improvements, including deep wells, pumping equipment, distribution system, etc. Estimated cost $50,000. Caldwell Engineering Co., 502 Ayers Bank Bldg., Jacksonville, Ill. is engineer.

Ill., Newton—The City will receive bids in June or July, for the construction of waterworks, including filtration plant with necessary equipment, etc. Estimated cost $50,000. Caldwell Engineering Co., 502 Ayers Bank Bldg., Jacksonville, Ill., is engineer.

Ia., Sac City — Russell & Fry, Storm Lake, Ia., will build with own forces, a Diesel power plant, etc., here. Estimated cost $40,000.

La., New Orleans — Bd. of New Basin Canal and Shell Road, E. Egan, Supt., will receive bids until February 10, for furnishing 1 direct generator, driven by gasoline motor, approximately 1250 w. 110 v., d.c.; also one 225 hp. 6 cylinder engine, complete. Total estimated cost $59,000.

Md., Baltimore — The Gold Dust Corporation, 239 West 30th St., New York, has retained Lockwood, Greene Co., Engrs. & Archts., 1 Pershing Sq., New York, to prepare plans for the construction of a new plant including power house, to be built on a 15 acre site, in the Canton district here.

Md., Conowingo—Susquehanna Power Co., owned by the Philadelphia Electric Co., 10th and Chestnut Sts., Philadelphia, Pa., awarded contract for the construction of a hydro electric plant developing up to 460,000 hp., to Stone and Webster, Inc., 120 Broadway, New York City, subject to approval of plans for electric plant by Federal Power Comn. The initial installation of generators will be 6, combined capacity 280,000 hp. The plans include a dam 3,680 ft. long and 103 ft. high, at the spillway across the Susquehanna River, four and a half miles above the Pennsylvania Railroad bridge, at Perryville, Md. Total estimated cost $52,000,000.

Mass., Dorchester—(Boston P. O.)—Dept. of Public Works, Boston, J. A. Rourke, Comr., awarded contract for electrical equipment, for pumping units at Calf Pasture Pumping Station here to Westinghouse Electric Co., 19 High St., Boston, $41,840. Noted January 19.

Mass., West Mansfield—Bd. of Aldermen, City Hall, Attleboro, plans the construction of a power plant here, to furnish power to the City of Attleboro.

Mo., Kansas City—Bd. of Fire and Water Commissioners will receive bids, about February 15, for the construction of a filtration plant and pumping station, incluling 17,000,000 gal. equalizing reservoir, motor driven centrifugal pumps, electric motors, switchboards and electrical equipment, outdoor substation, 100 mgd. filter plant and pumping station, river intake and pumping station, high pressure pumping station, etc. Fuller & Maitland, 600 Walnut St., are engineers.

Mo., St. Louis—H. A. Sodine, and others, c/o Majestic Hotel, having preliminary plans prepared for the construction of a hotel and theatre building, on the site of the present Laclede Hotel, Chestnut and 6th Sts. Estimated cost $1,000,000.

N. Y., Buffalo—M. M. Swerloff, Prudential Bldg., having plans prepared for the construction of a 4 story apartment, on Delaware Ave. Estimated cost $500,000. J. P. Geigand, 346 Herman St., is architect.

N. Y., New York — New York Central Railroad, Lexington Ave., awarded contract for the construction of a 14 story hotel, at Lexington Ave. and 48th St., to Todd, Robertson, Todd Engineering Corporation, 347 Madison Ave. Estimated cost $10,000,000.

N. Y., New York—Oceanic Investing Co., c/o Cross & Cross, 385 Madison Ave., Engrs. & Archts., is having plans prepared for the construction of a 15 story office building at 42nd St. and Fifth Ave. Estimated cost $1,500,000.

N. Y., White Plains — Gedney Farms Hotel c/o K. M. Murchison, 101 Park Ave., New York, is having plans prepared for the construction of a hotel here. Estimated cost $500,000.

O., Piqua—Meteor Motor Car Co., is having preliminary sketches made for the construction of an automobile factory, including separate power house. Estimated cost $150,000. Private plans.

Okla., Chandler—The Chandler Ice Co. awarded contract for the construction of a 55 x 110 ft. ice plant, to B. R. Dustin, Chandler.

S. C., Columbus — The State Dept., awarded contract for the construction of a 5 story, state office building, to the Fuller Construction Co., 175 Fifth Ave., New York. Estimated cost $750,000.

Tenn., McKenzie—The City, C. R. Woods, Supt. of Water and Light Co., plans water works improvements, including the restoration of two wells, pumps, etc. J. R. Costen is Mayor.

Tenn., Memphis—U. S. Veterans Bureau, Construction Division, 791 Arlington Bldg., Washington, D. C., will receive bids until Feb. 24, for the construction of addition to Veterans Hospital, including ice plant, laundry, etc., on Lamar Blvd.

Tenn., Nashville—George Peabody College for Teachers, 21st Ave., South, B. R. Payne, Pres., plans to raise funds for the construction of college buildings, including heating plant, power house, and miscellaneous building, estimated cost $120,000. Total estimate $3,600,000.

Tex., Brady — The City voted $100,000 bonds, for water works extension, including pumps. E. L. Jones is mayor. Engineer not selected.

Tex., Cayon — Kelso-Wurdack Co., having plans prepared for the construction of a 20 ton, ice plant. Estimated cost $35,000. Private plans. Machinery for complete plant will be required.

Tex., Claude—The City, G. D. Caldwell, Secy., will soon receive bids for improvements in the city lighting system. Estimated cost $35,000. Gnatt-Baker Co., 1116 Main St., Oklahoma City, Okla., is engineer.

Tex., Dallas—Y. O. McAdams, 3412 Beverly Dr., plans the construction of a 16 story, office building, here. Estimated cost $1,200,000. C. D. Hill & Co., Central Bank Bldg., is architect.

Tex., Dilly—The City plans an election February 14, to vote $25,000 bonds for an electric generating and ice plant, and $30,000 for a water works system, including pumping equipment, etc. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonia are engineers.

Tex., Elgin—The City c/o the Mayor, plans the construction of a new pumping system, and extension to water works. Estimated cost $50,000. Terrell Bartlett, Engineers, Calcasieu Bldg., San Antonio, are engineers.

Tex., Lalesa—The city voted $40,000 bonds, for the construction of water mains and pumping equipment. J. Walker is mayor. Engineer not selected.

Tex., Roby—The City, T. E. Alvis, Mayor, has voted a bond issue, for water works improvement, including extension of mains, pumping plant, etc. Estimated cost $40,000. Engineer not selected.

Tex., Trinidad—The Texas Utilities Company, subsidiary of the Southwestern Power and Light Co., Dallas, awarded contract for the construction of a power plant, initial capacity 40,000 kw., ultimate capacity 150,000 kw., on the Trinity River, to Texas Construction Co., Dallas, $3,000,000.

Va., Charlottesville—Jackson Park Hotel Co., c/o S. S. Johnson and R. O. Brennan, Peoples Bank Bldg., Lynchburg, Archts., will soon award contract for the construction of a 9 story hotel, here. Estimated cost $500,000. Van Rensselaer Saxe, Knickerbocker Bldg., is engineer.

Wash., Everett—The Puget Sound Power and Light Co., Seattle, 1925 budget for construction work provides for expenditure of $9,000,000. Completion of the Baker River Project, to develop 40,000 hp., cost $6,000,000; 70 mi. transmission line required in connection with the development, $800,000; improvements to the present distributing system $1,500,000. Substation at Beverly Park, 3 miles south of Everett, total capacity 27,000 kva., cost $750,000; the equipment includes transformers, ranging from 60,000 to 110,000 v., oil switches, etc.; 13,500 kva substation at Sedro Valley, cost $300,000. In addition to the above, improvements and extension to all properties throughout the Pacific Northwest are planned.

Wash., Seattle—City Council has passed an ordinance providing for the issuance of $15,000,000 in city light bonds, of which $7,000,000 will be expended for the extension of electric light lines, purchase of 5 substations, and equipment for an electric lighting plant. The remaining $8,000,000 is to be used for the further development of the Skagit project at Ruby Creek.